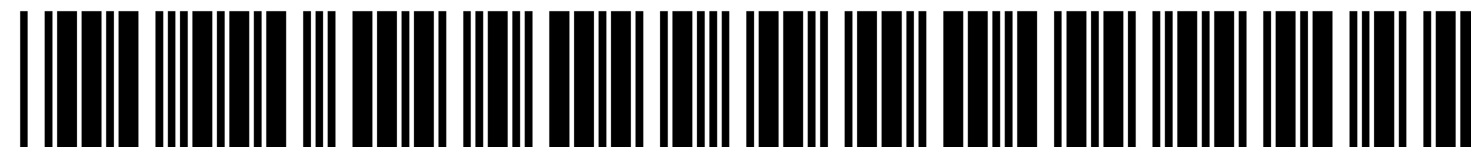

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Ishida et al.

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(45) **Date of Patent: Dec. 29, 2020**

(54) **ELECTRONIC COMPONENT HANDLER HAVING A VERTICALLY MOVABLE LIGHT SOURCE**

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(73) Assignee: **Seiko Epson Corporation**

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(52) **U.S. Cl.**
CPC ***G01R 31/2893*** (2013.01)

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CPC G01R 31/2893; G01R 31/2867; G01R 31/01; G01R 31/26; B65G 2201/02; B65G 43/08; B65G 49/07; G01V 8/00; G01C 11/26; G06T 7/0008; G06T 7/001; G06T 2207/20212; G06T 2207/30148; H01L 21/67265; H01L 21/67333; G06F 3/14
See application file for complete search history.

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Primary Examiner — Vinh P Nguyen
(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

An electronic component handler that transports an electronic component to an electronic component placement unit on which the electronic component is placed includes: a transport unit that transports the electronic component; a light irradiation unit that irradiates the electronic component placement unit with light; and a vertical direction moving mechanism unit that has a guide that supports the light irradiation unit and guides the light irradiation unit in a vertical direction.

9 Claims, 16 Drawing Sheets

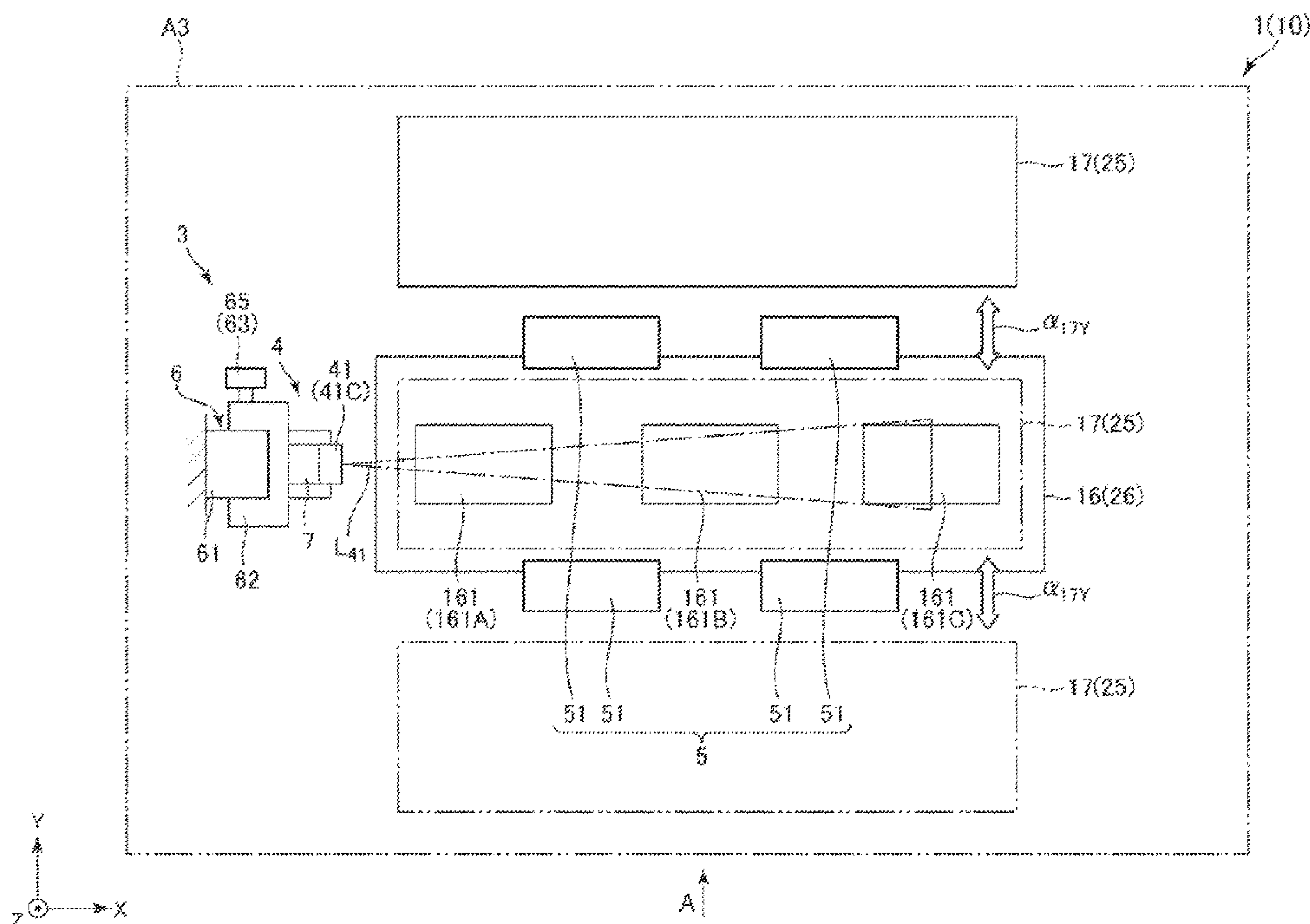


FIG. 1

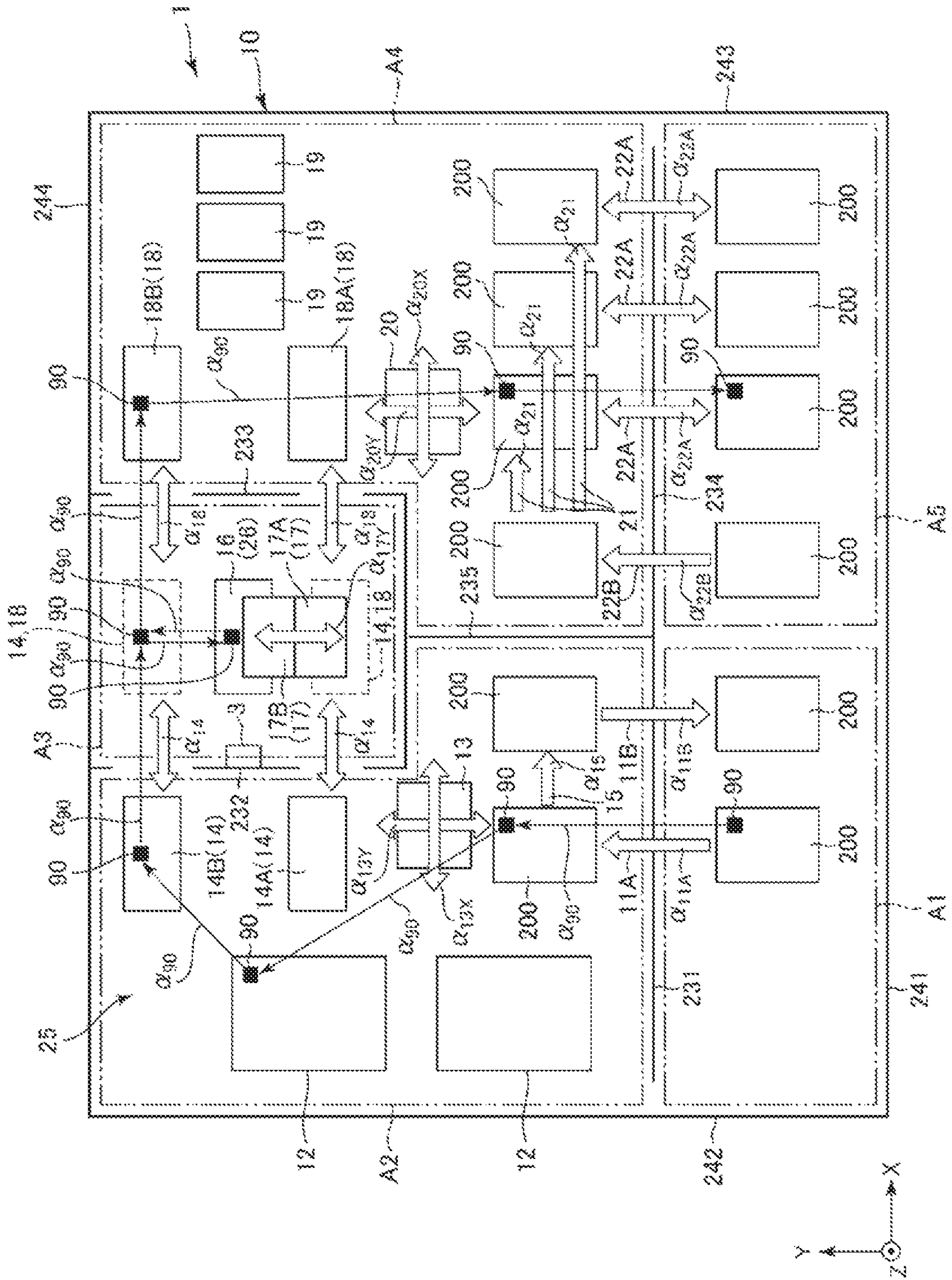


FIG. 2

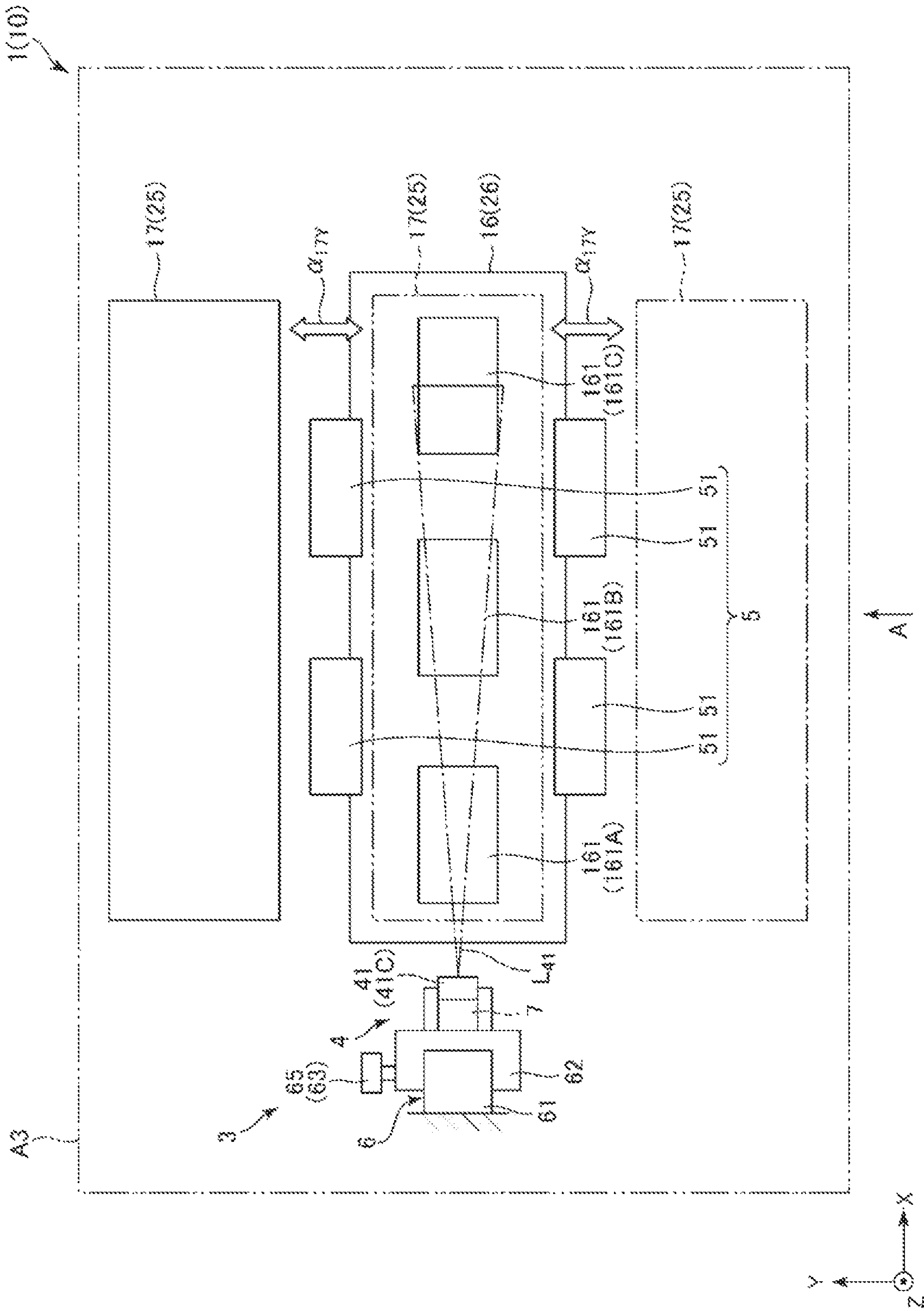


FIG. 3
1(10)
17(25)
17(25)
16(26)
17(25)
α_{17Y}
α_{17Y}
161
(161C)
51
51
51
5
A
161
(161B)
51
51
161
(161A)
L_{41}
41
(41C)
4
7
62
65
(63)
3
61
6
A3
X
Y
Z

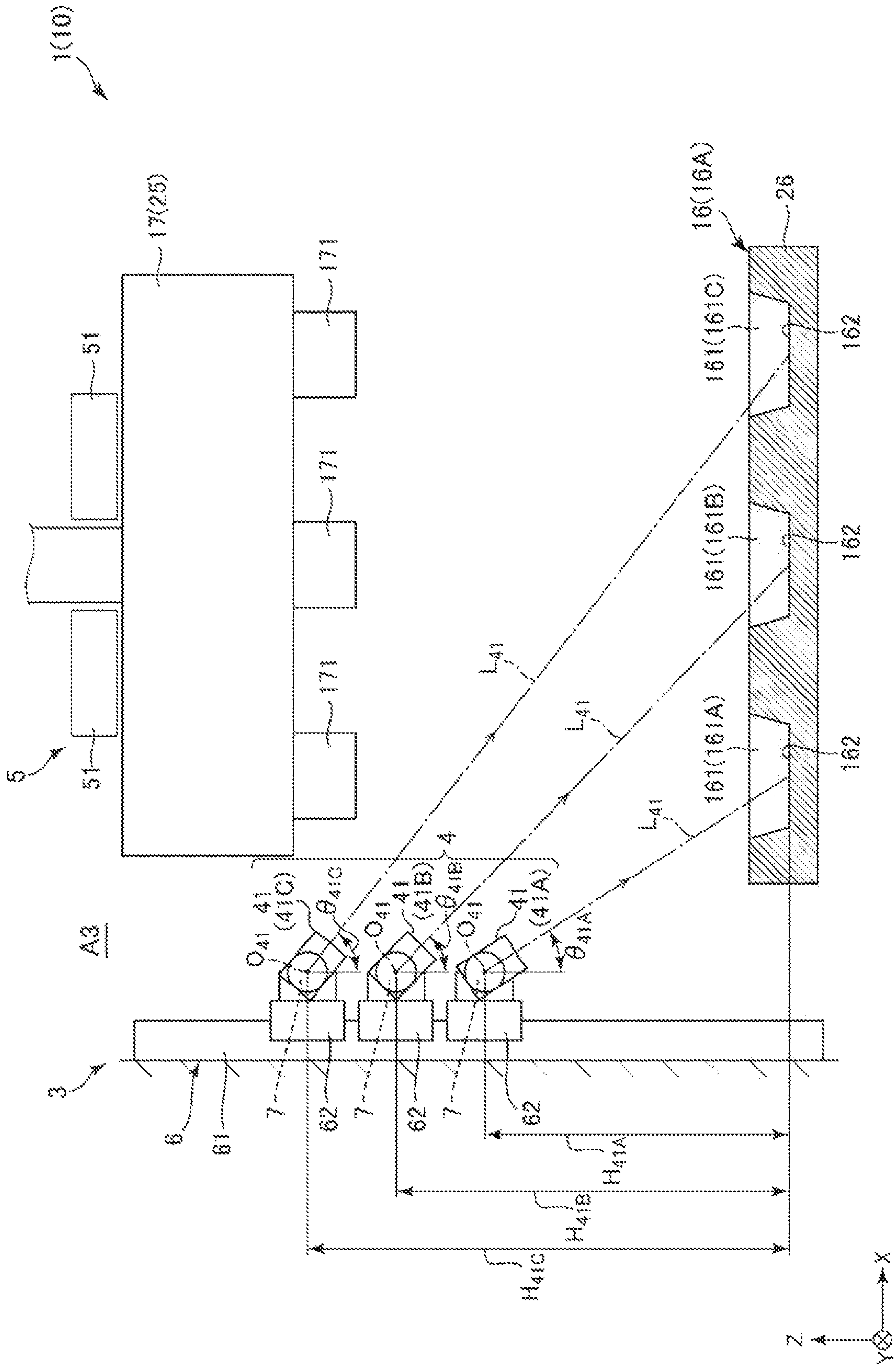


FIG. 4
1(10)
17(25)
16(16A)
26
51
171
5
L41
161(161C)
161(161B)
161(161A)
162
4
A3
O41
41
(41C)
(41B)
(41A)
θ41C
θ41B
θ41A
3
6
61
7
62
H41A
H41B
H41C
X
Z
Y

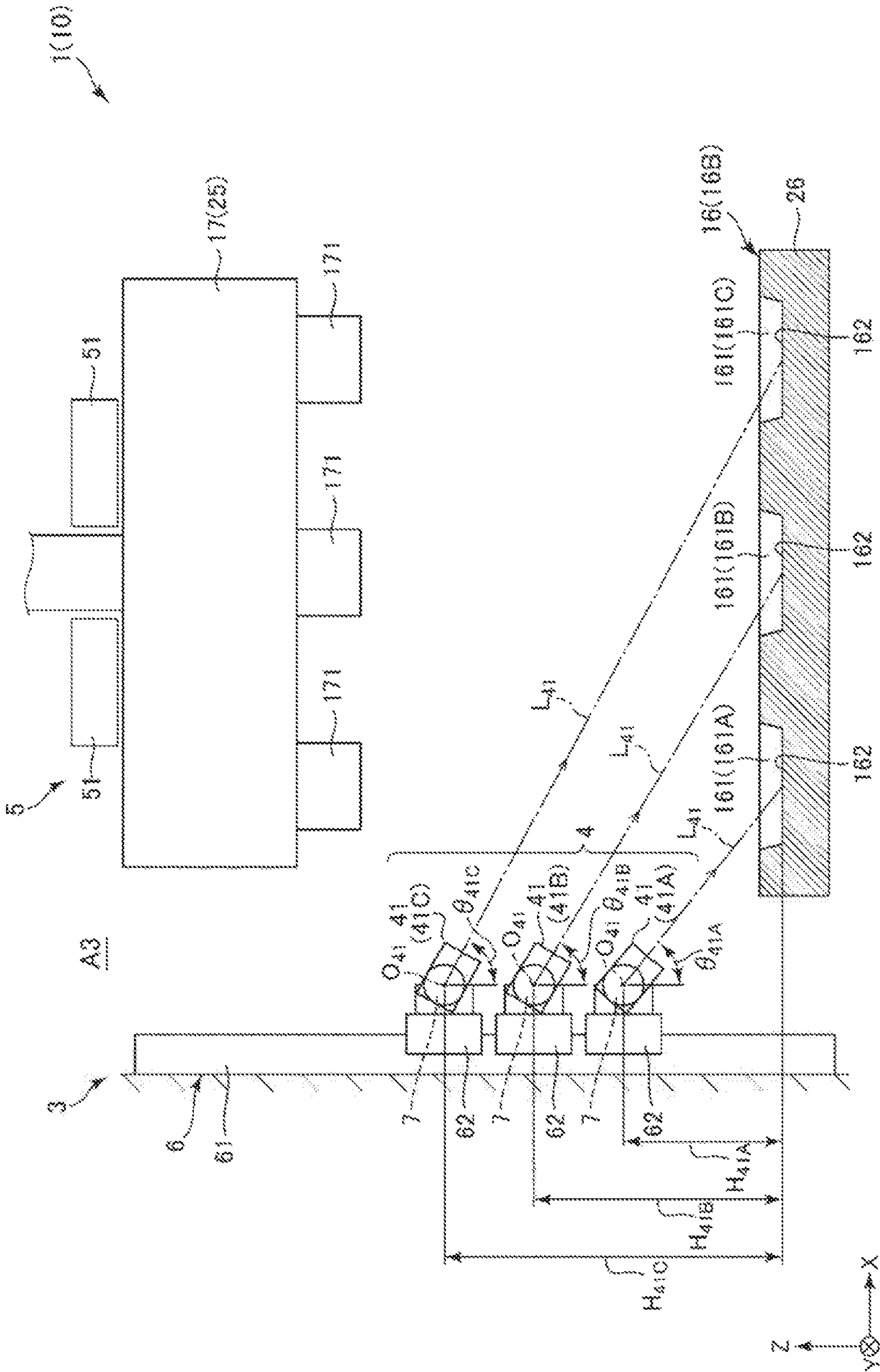


FIG. 5

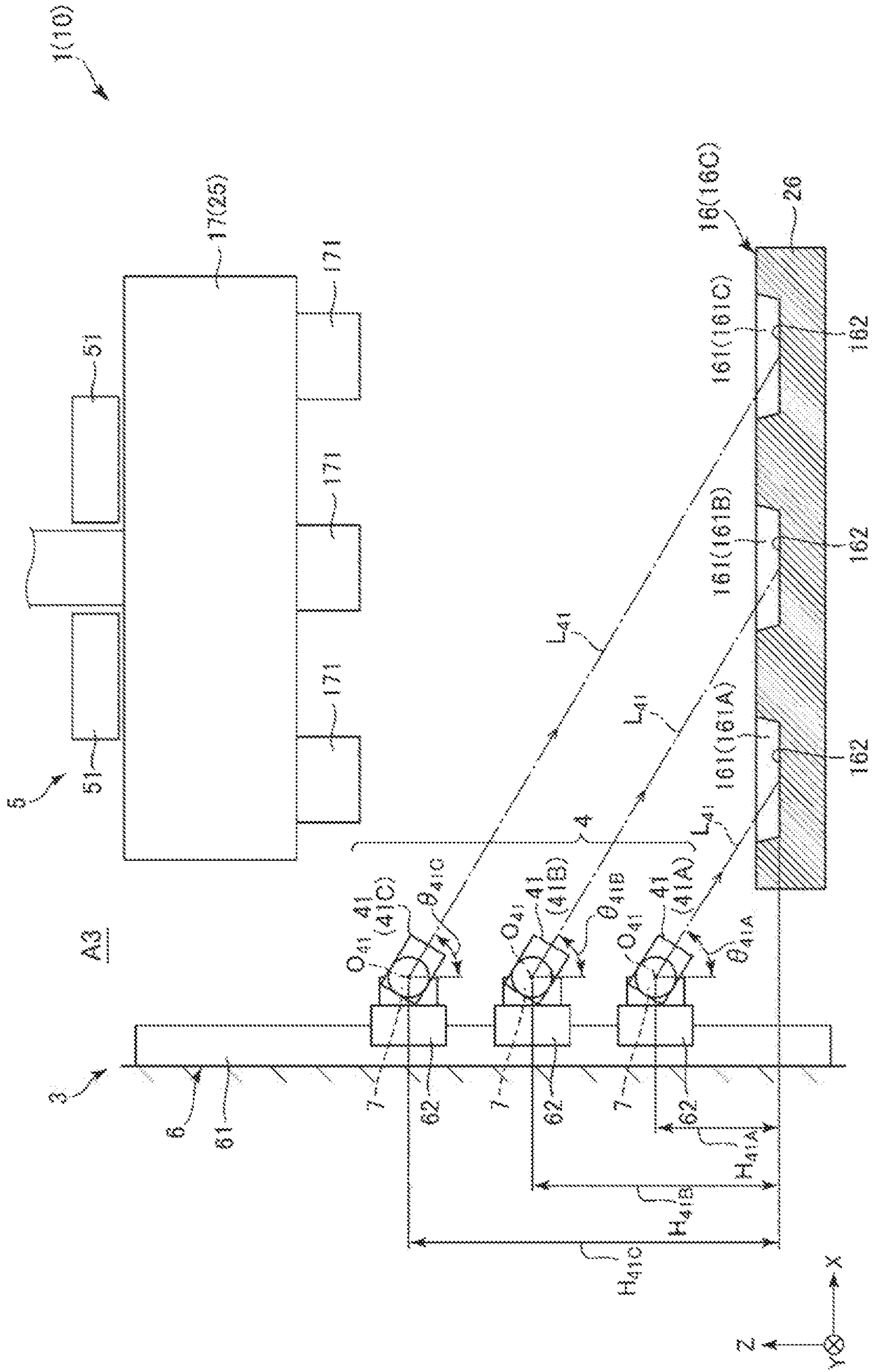


FIG. 6
1(10)
17(25)
171
51
5
A3
3
6
61
62
7
4
16(16C)
26
161(161C)
161(161B)
161(161A)
162
41 (41A)
41 (41B)
41 (41C)
X
Y
Z

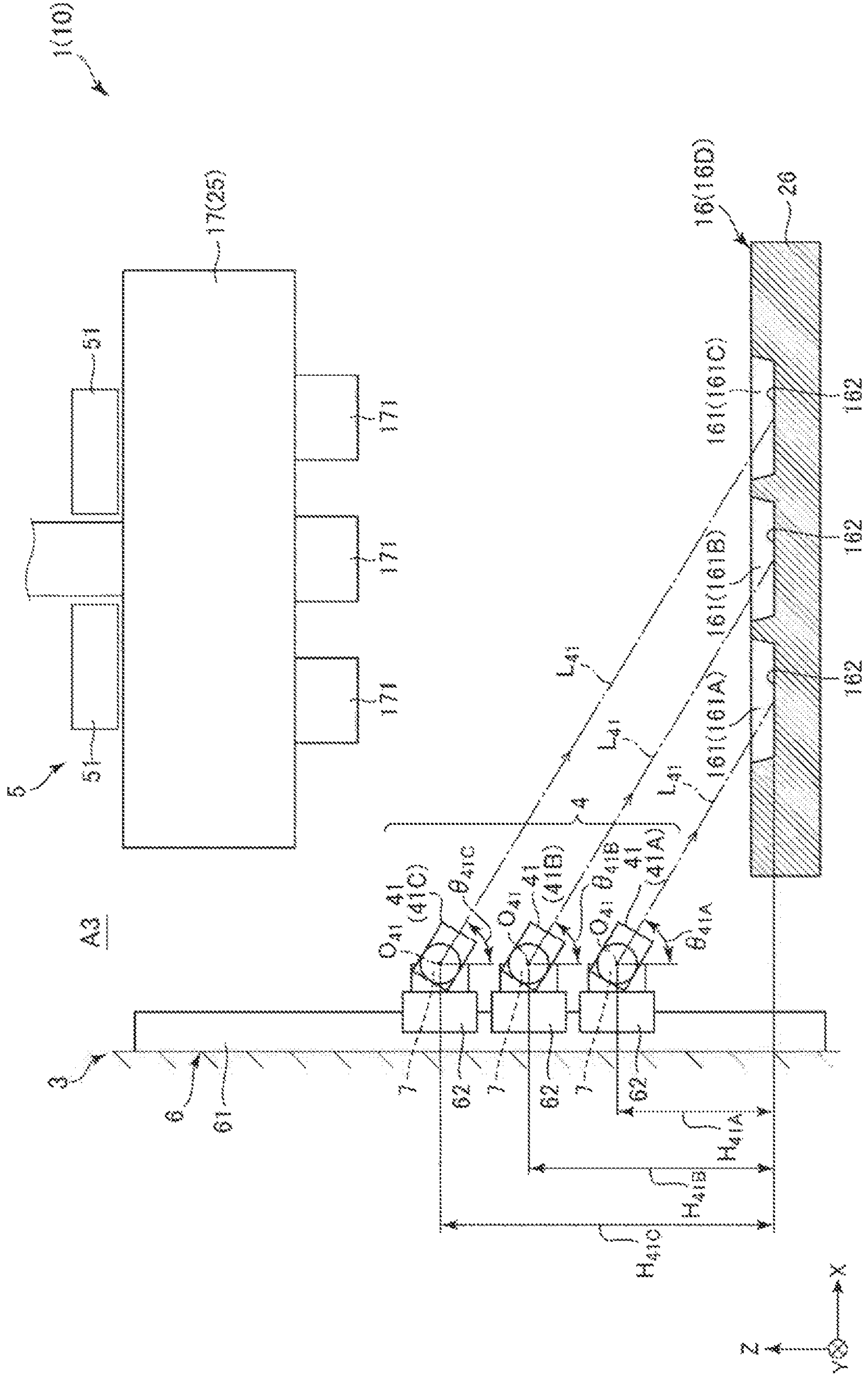


FIG. 7
1(10)
5
51
17(25)
171
A3
3
6
61
62
7
41 (41A)
41 (41B)
41 (41C)
4
L41
16(16D)
26
161(161A)
161(161B)
161(161C)
162
H41A
H41B
H41C
X
Y
Z

FIG. 8

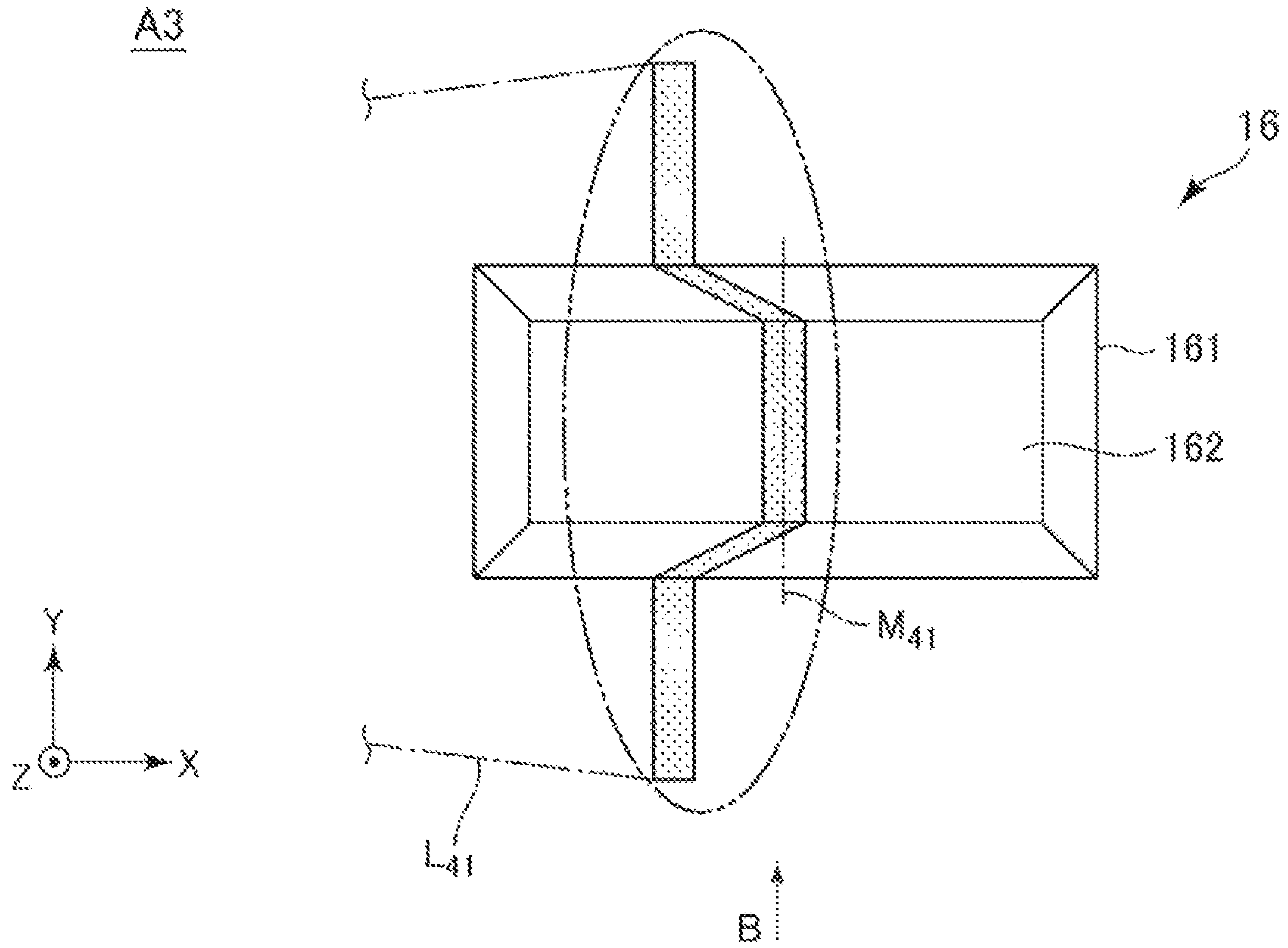


FIG. 9

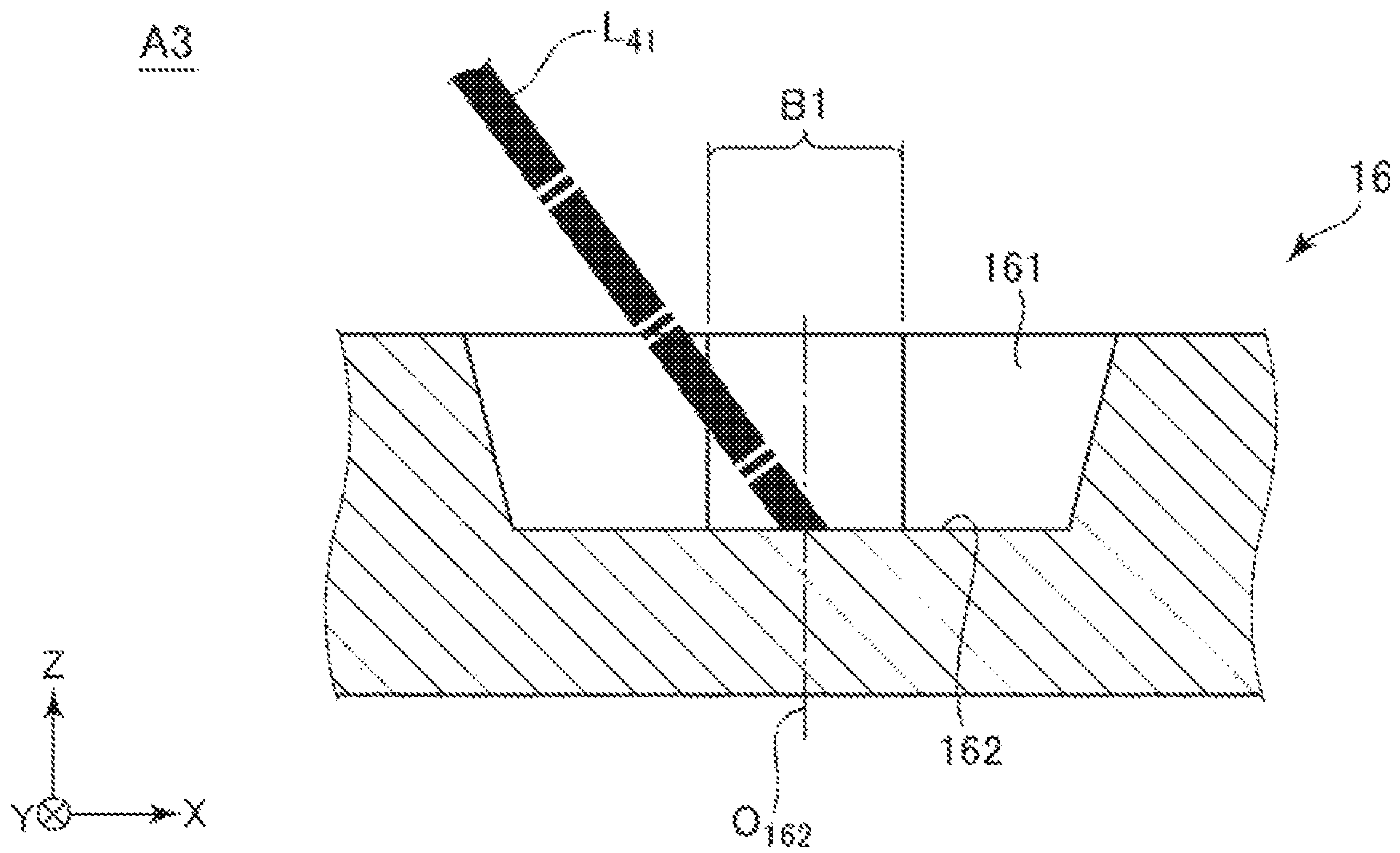


FIG. 10

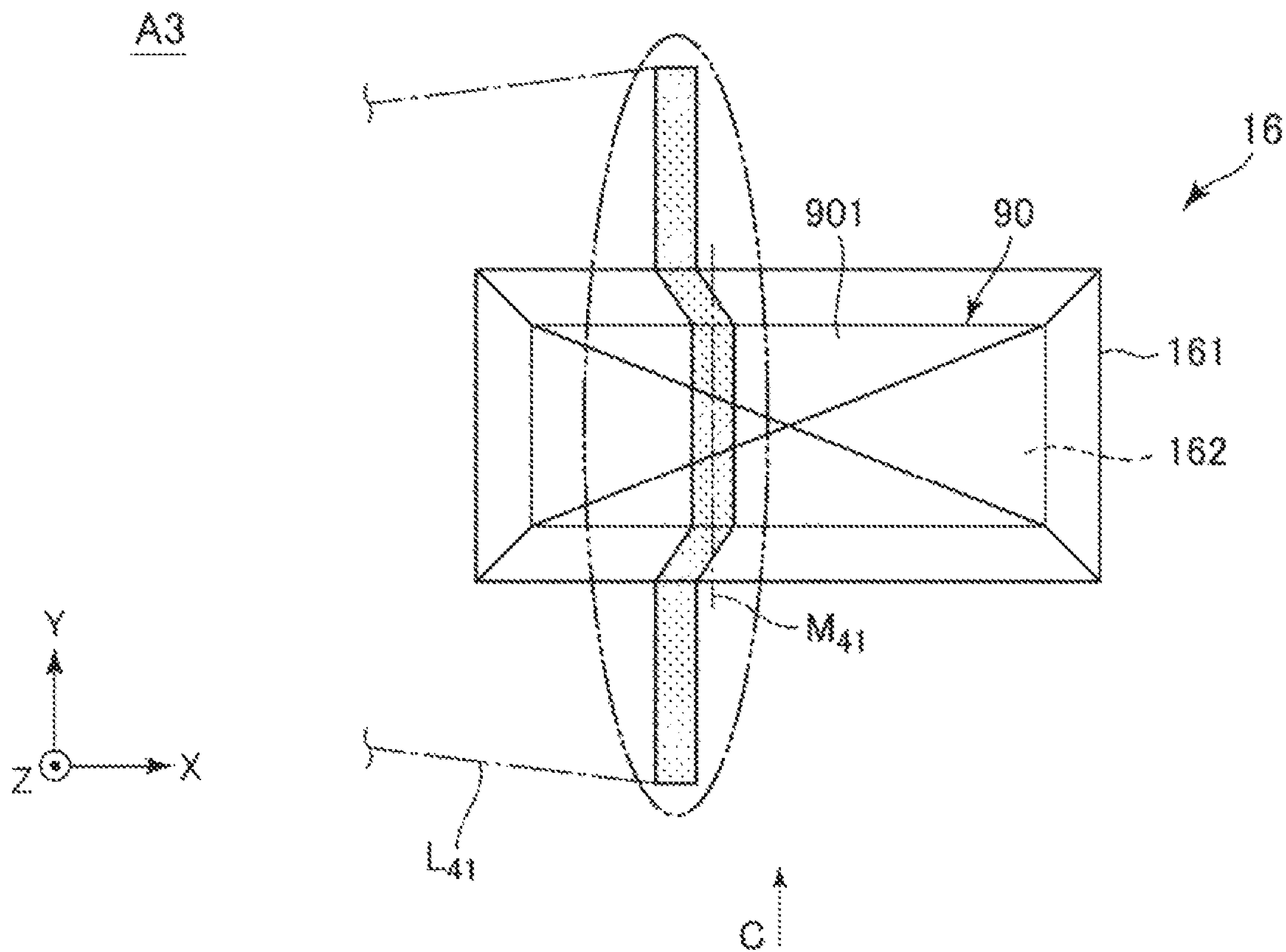


FIG. 11

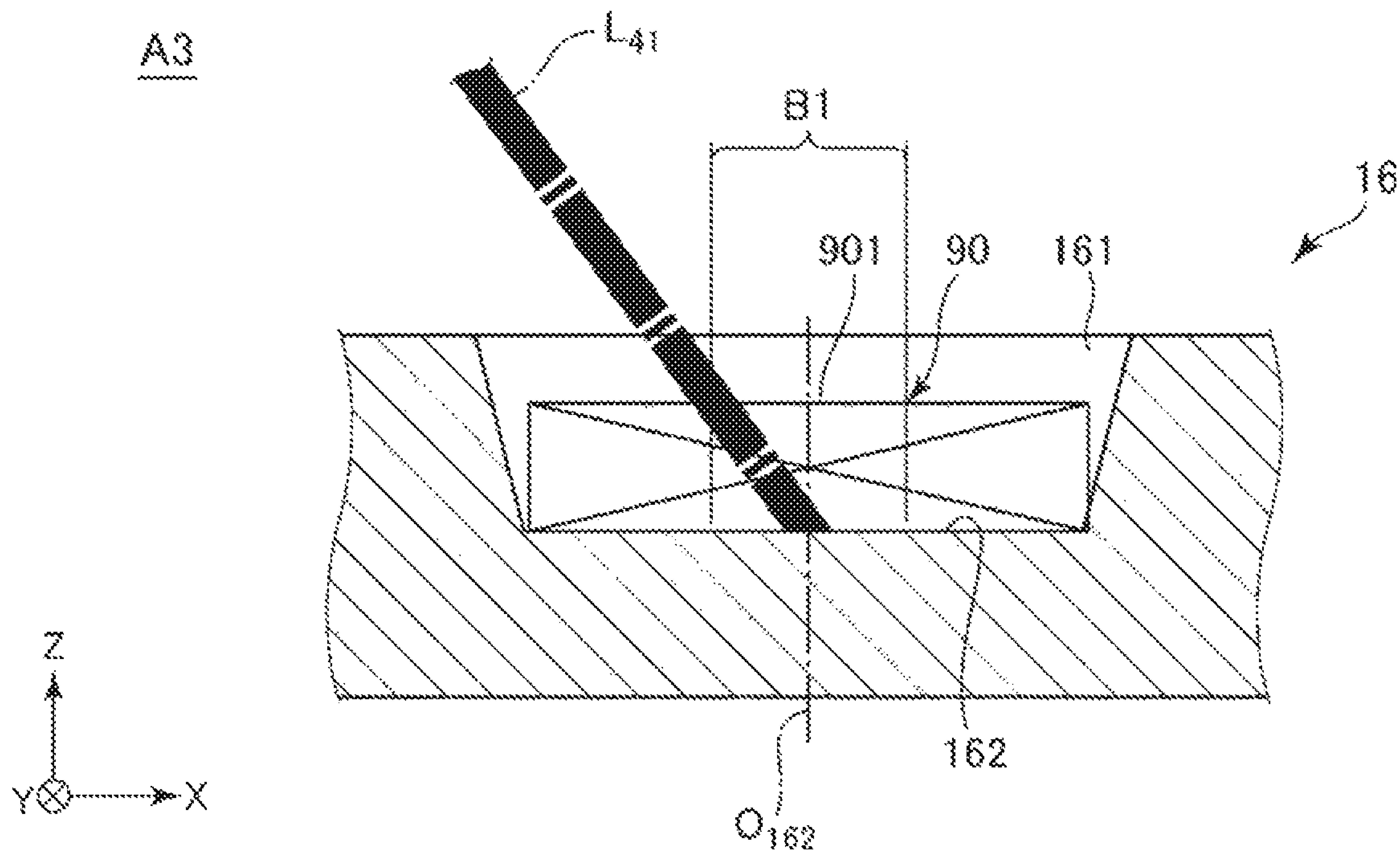


FIG. 12

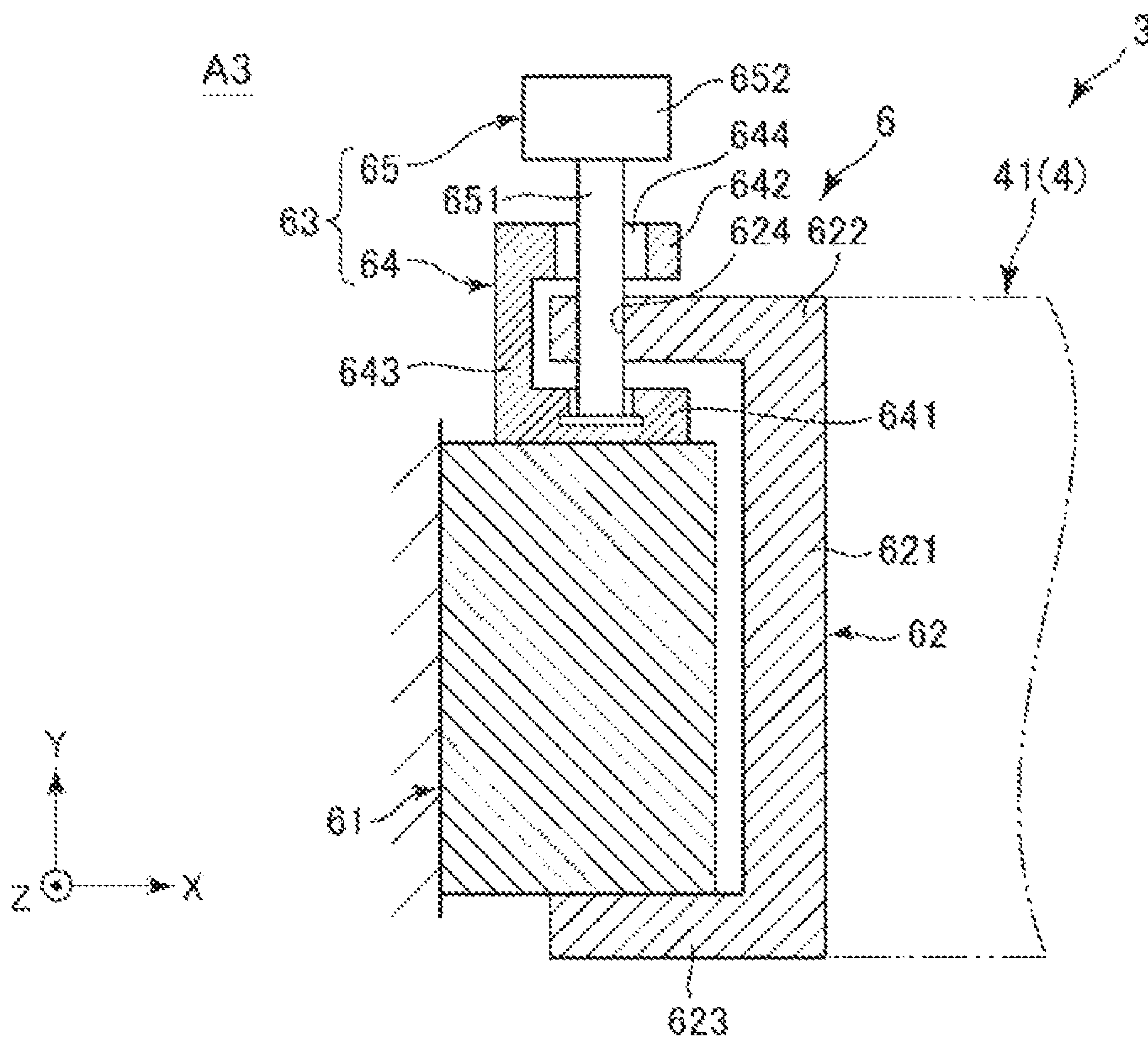


FIG. 13

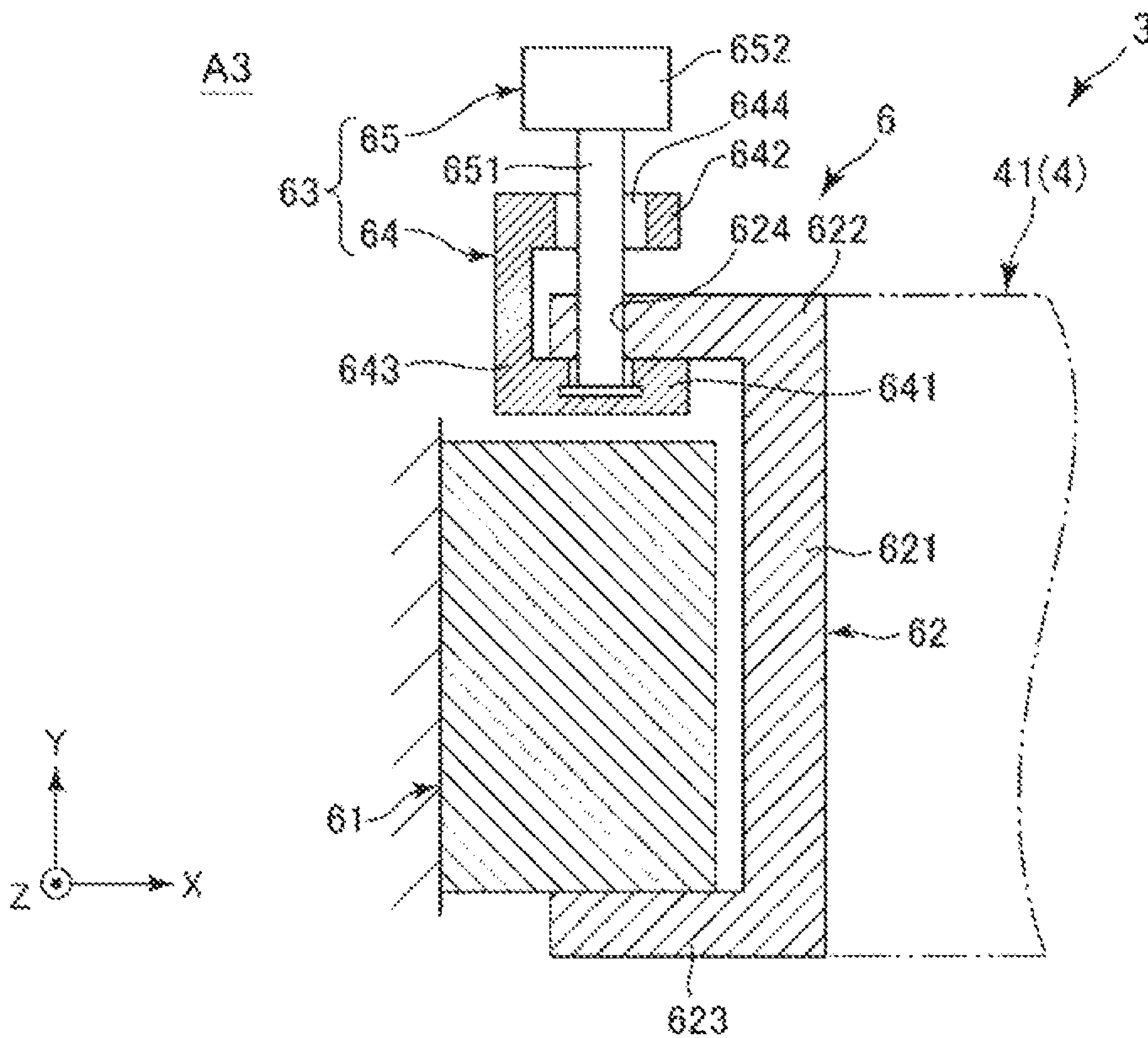


FIG. 14

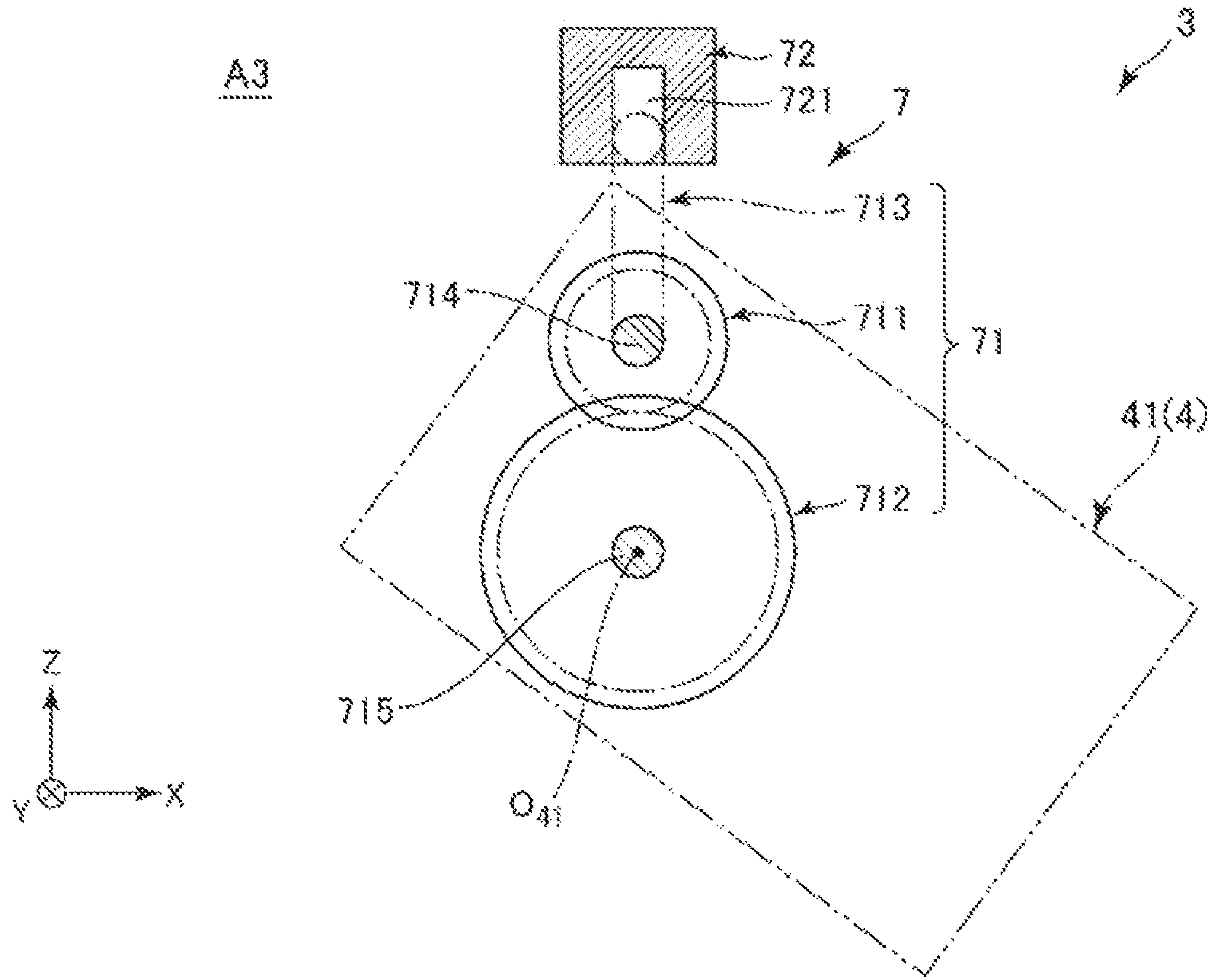


FIG. 15

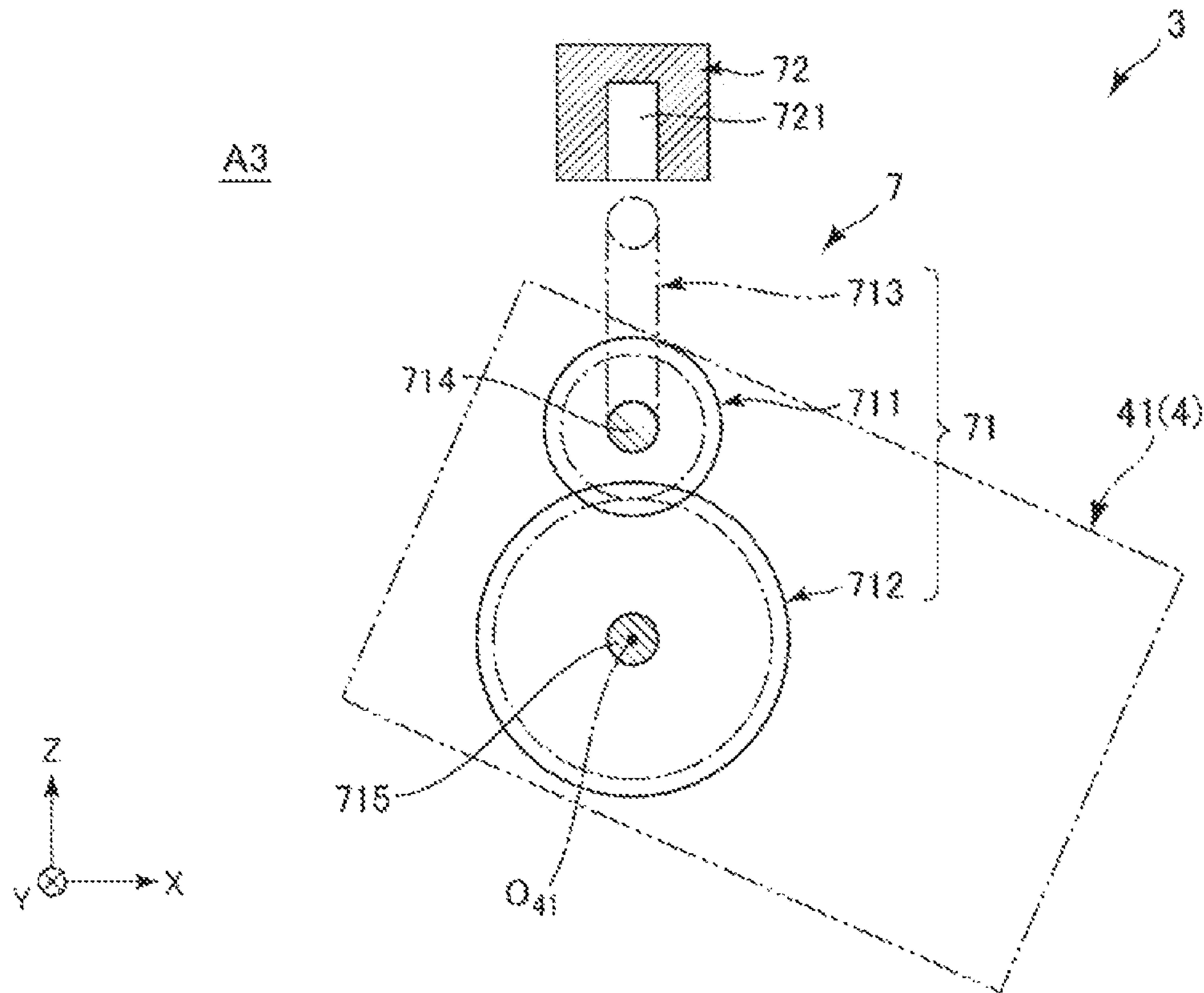
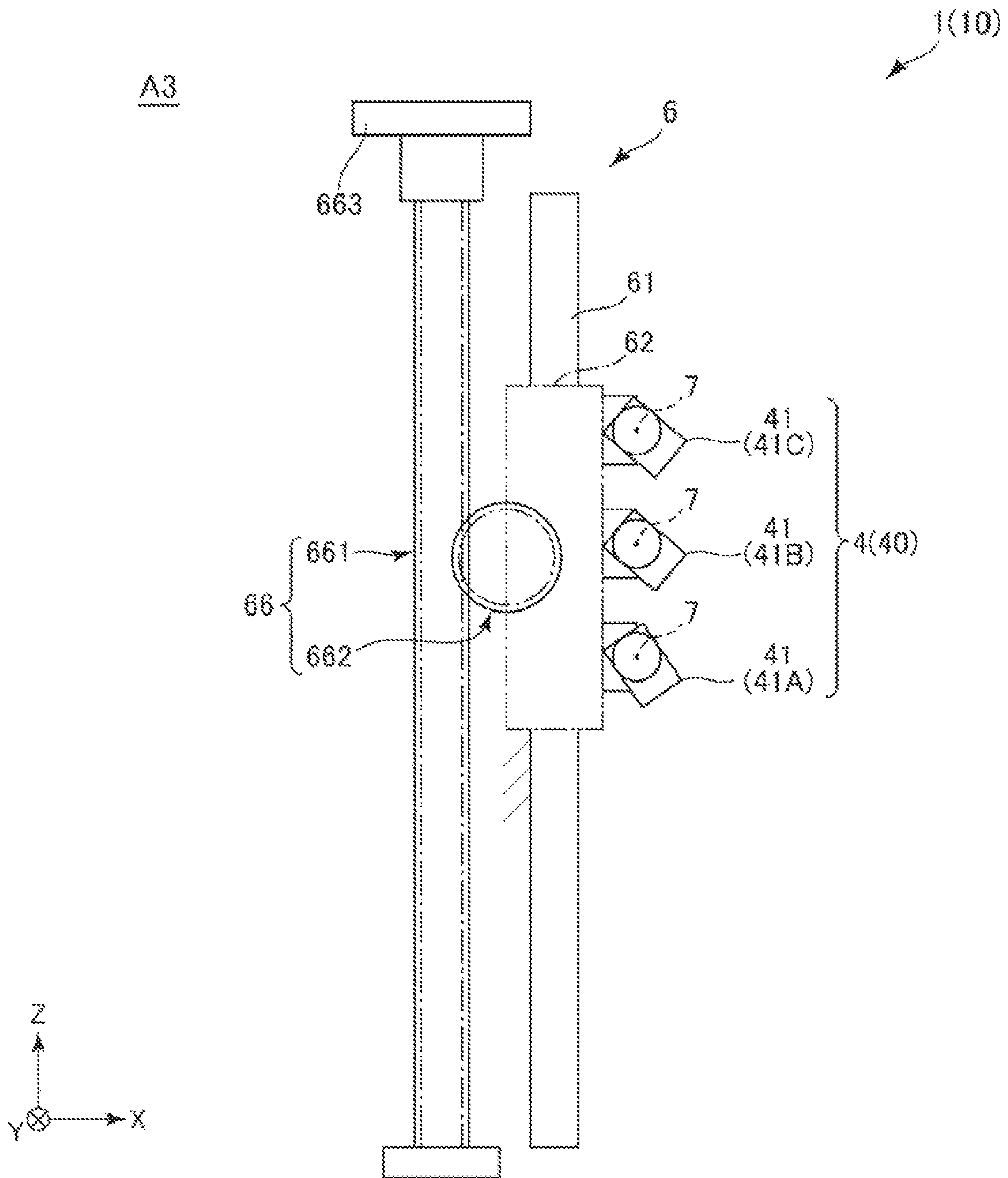


FIG. 16

FIG. 17



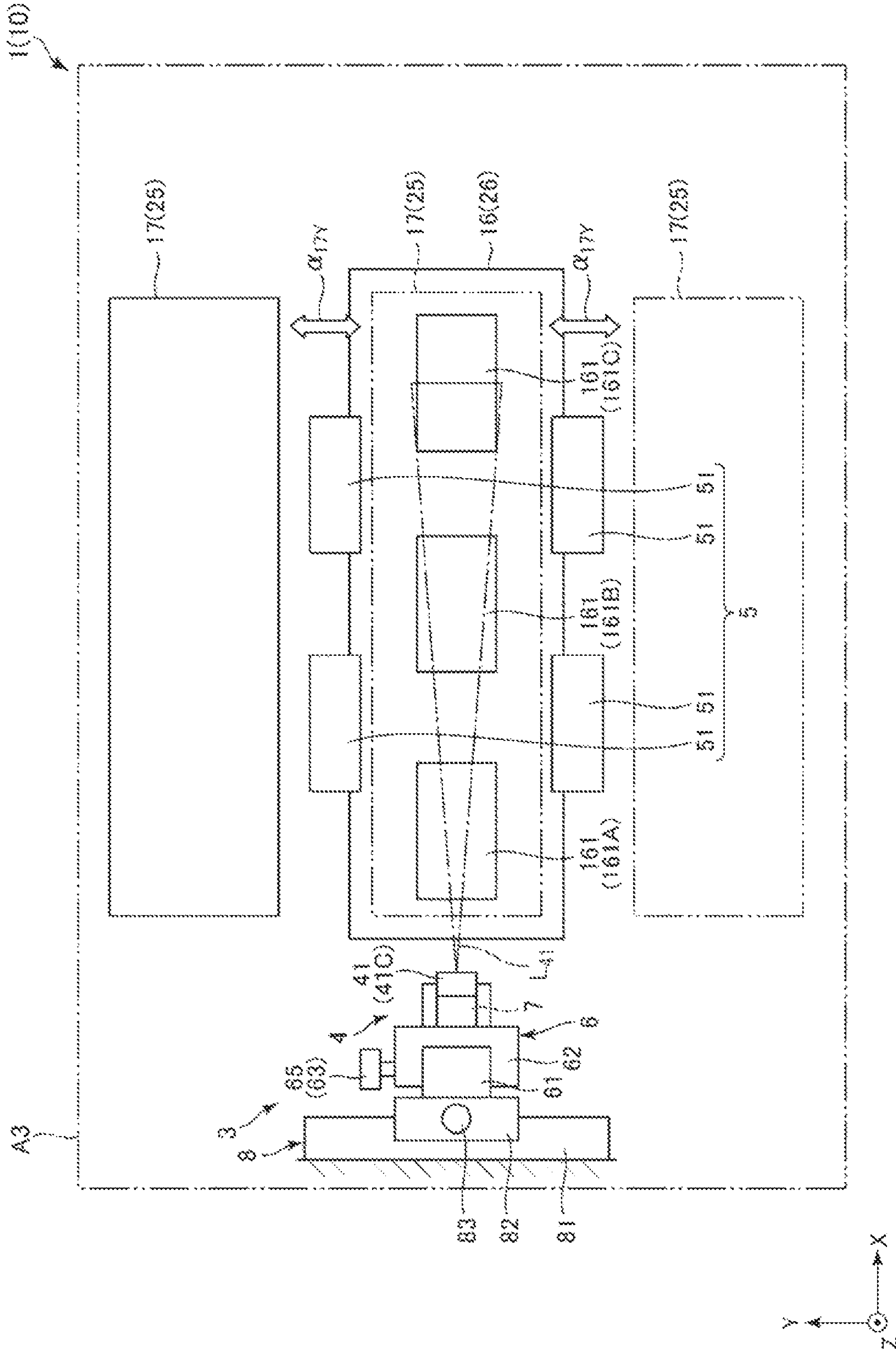


FIG. 18
1(10)
17(25)
16(26)
161
(161A)
161
(161B)
161
(161C)
51
5
41
(41C)
7
6
62
61
65
(63)
4
3
8
83
82
81
A3
X
Y
Z

FIG. 19

41(4)
414
L_{41}
L_{41}
415
413
412
411

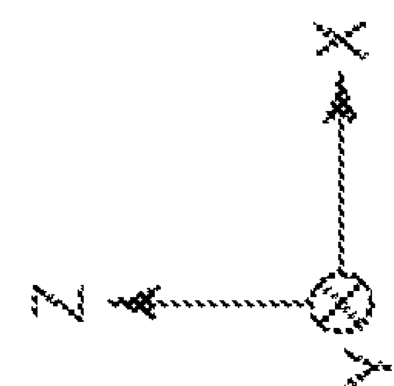


FIG. 20

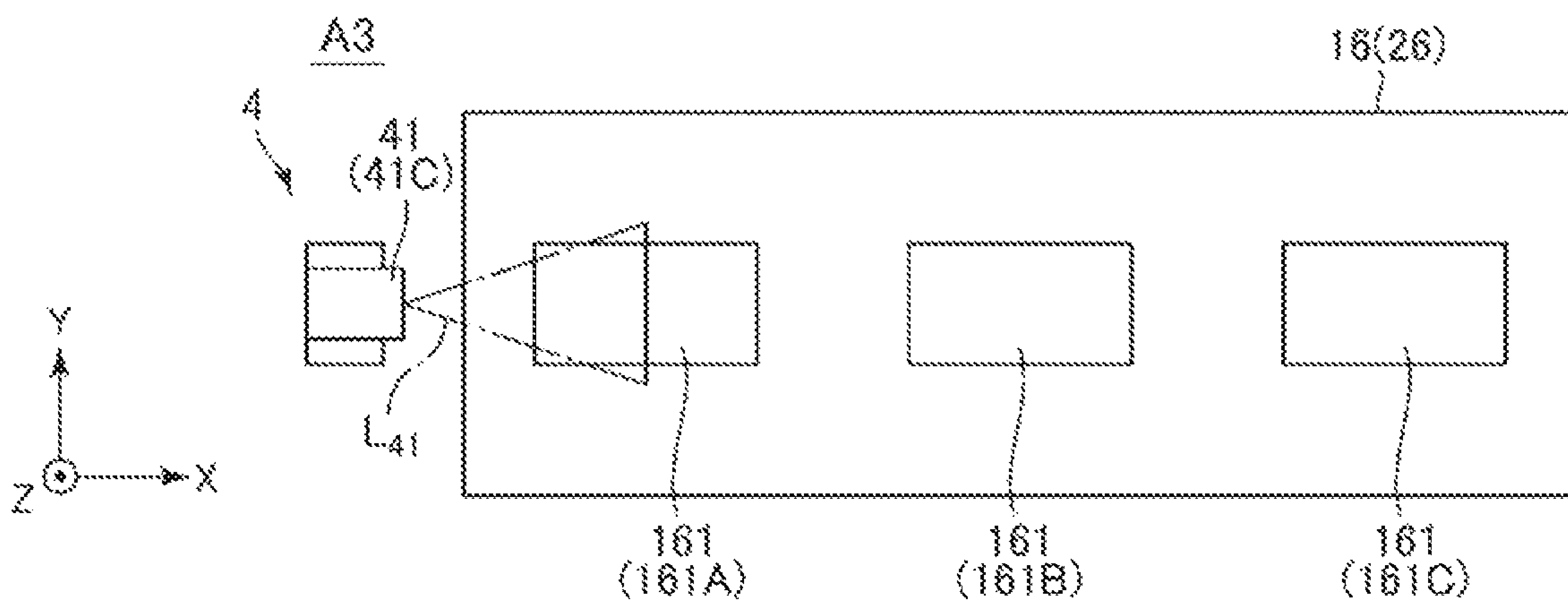


FIG. 21

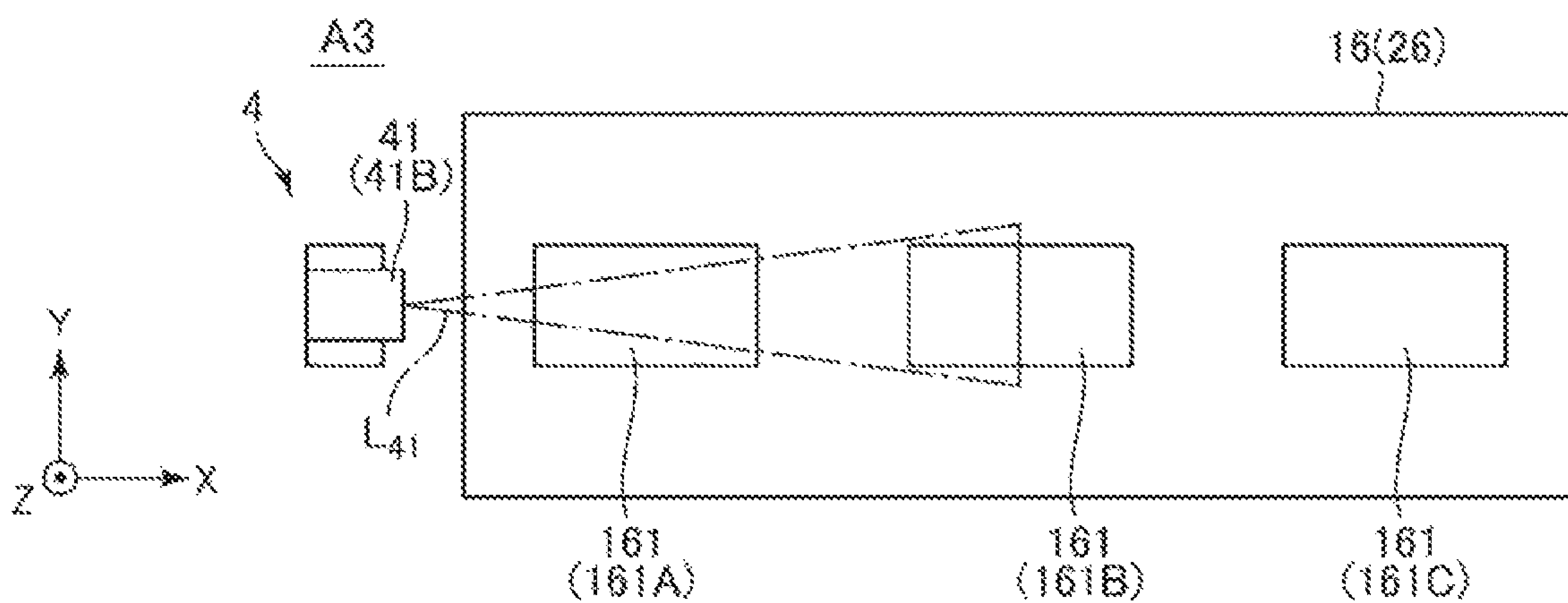
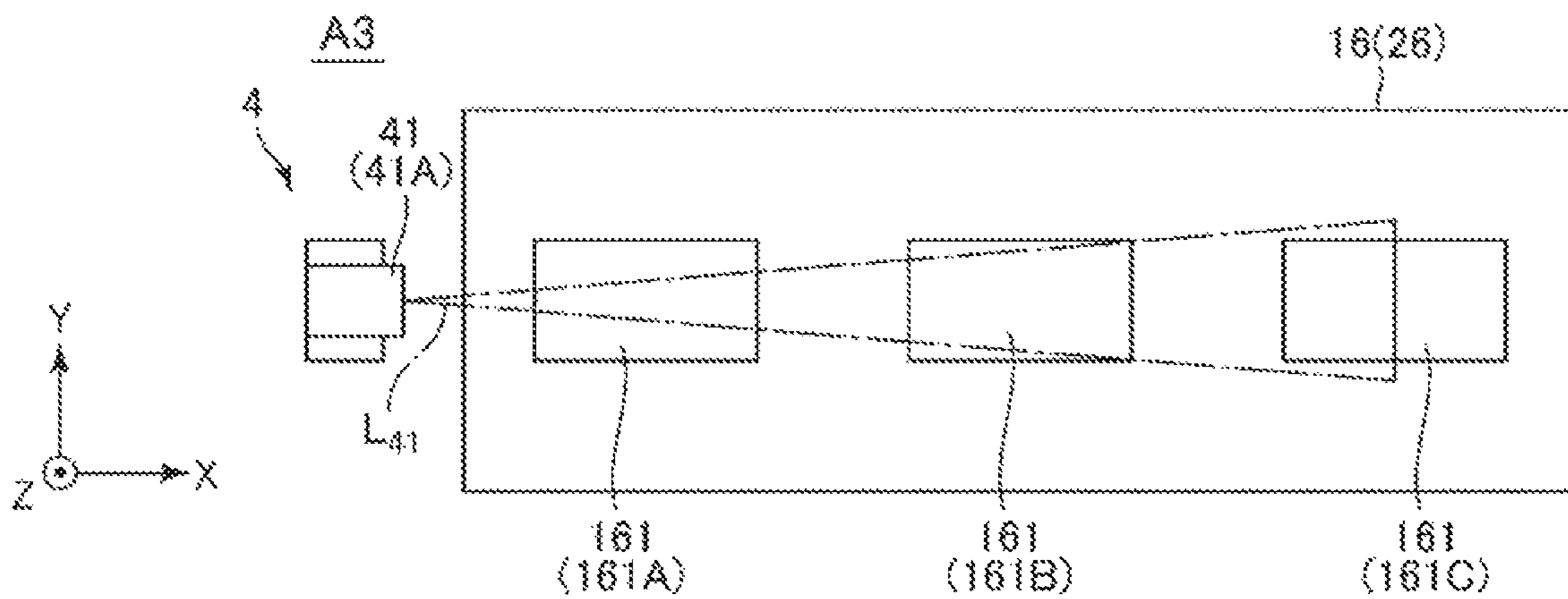


FIG. 22



ELECTRONIC COMPONENT HANDLER HAVING A VERTICALLY MOVABLE LIGHT SOURCE

BACKGROUND

1. Technical Field

The present invention relates to an electronic component handler and an electronic component tester.

2. Related Art

In the related art, a tester that performs electric test on electronic components such as an IC device, for example, is known (see JP-A-2014-196908, for example. The tester described in JP-A-2014-196908 is configured such that an IC device is transported to a test socket, is then placed on the test socket, and is subjected to test in a case in which test is performed on the IC device. According to the tester described in JP-A-2014-196908, it is determined whether or not the IC device remains on the test socket, that is, whether or not the IC device is present prior to the test on the IC device. It is necessary to make this determination since there is a concern that the IC device to be tested overlaps with the remaining device and an accurate test result is not obtained in a case in which the IC device remains on the test socket, for example. According to the tester described in JP-A-2014-196908, two images are obtained at different imaging timings (before and after the transport of the IC device), a difference (image difference) between these two images is detected, and the determination regarding whether or not the IC device is present is made on the basis of a result of the detection.

However, according to the tester described in JP-A-2014-196908, it is not possible to adjust a position and the like of a laser light source for emitting slit light in the aforementioned tester while it is necessary to adjust the position (especially, the position in the vertical direction) and the orientation of the laser power source.

SUMMARY

An advantage of some aspects of the invention is to solve at least a part of the problems described above, and the invention can be implemented as the following configurations.

An electronic component handler according to an aspect of the invention includes: a transport unit that transports an electronic component; a region in which an electronic component placement unit on which the electronic component is placed is able to be disposed; a light irradiation unit that is able to irradiate the electronic component placement unit with light; and a vertical direction moving mechanism unit that movably supports the light irradiation unit such that the position thereof in the vertical direction changes.

It is preferable that the vertical direction moving mechanism unit has a guide that guides the light irradiation unit in the vertical direction.

It is preferable that the vertical direction moving mechanism unit has a decelerator that decelerates moving speed of the light irradiation unit.

It is preferable that the vertical direction moving mechanism unit has a movement adjustment unit that adjusts a position of the light irradiation unit at a destination of movement when the movement of the light irradiation unit stops.

It is preferable that the light irradiation unit has a plurality of laser light sources that emit laser light.

It is preferable that the light irradiation unit is a light source unit in which the plurality of laser light sources are integrated as a unit.

It is preferable that the vertical direction moving mechanism unit is configured such that the vertical direction moving mechanism is able to independently move the respective laser light sources.

It is preferable that the vertical direction moving mechanism unit is configured such that the vertical direction moving mechanism unit is able to collectively move the respective laser light sources in the same direction.

It is preferable that the respective laser light sources are disposed in the vertical direction and that the laser light sources located on further upward are used such that angles relative to the vertical direction of the laser light sources are small.

It is preferable that the electronic component handler includes a turning mechanism unit that supports the light irradiation unit such that the light irradiation unit is able to turn.

It is preferable that the turning mechanism unit has a decelerator that decelerates an angular speed of the light irradiation unit.

It is preferable that the turning mechanism unit has a turning adjustment unit that adjusts a position of the light irradiation unit at a destination of turning when the turning of the light irradiation unit stops.

It is preferable that the light irradiation unit has a plurality of laser light sources that emit laser light and that the turning mechanism unit is configured to support the respective laser light sources such that the respective laser light sources are able to independently turn.

It is preferable that the electronic component handler includes a horizontal direction moving mechanism unit that movably supports the light irradiation unit in a horizontal direction.

It is preferable that the electronic component handler includes an imaging unit that images the electronic component placement unit.

An electronic component tester according to another aspect of the invention includes: a transport unit that transports an electronic component; a test unit that has an electronic component placement unit on which the electronic component is placed and that is able to test the electronic component placed on the electronic component placement unit; a region in which the test unit is able to be disposed; a light irradiation unit that is able to irradiate the electronic component placement unit with light; and a vertical direction moving mechanism unit that movably supports the light irradiation unit such that a position thereof in the vertical direction changes.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

FIG. **1** is a schematic perspective view of an electronic component tester according to a first embodiment of the invention when viewed from a front side.

FIG. **2** is a schematic plan view illustrating an operation state of the electronic component tester illustrated in FIG. **1**.

FIG. **3** is an enlarged plan view in a test region in FIG. **2**.

FIG. **4** is a partial sectional view (example) when viewed in the direction of the arrow A in FIG. **3**.

FIG. **5** is a partial sectional view (example) when viewed in the direction of the arrow A in FIG. **3**.

FIG. **6** is a partial sectional view (example) when viewed in the direction of the arrow A in FIG. **3**.

FIG. **7** is a partial sectional view (example) when viewed in the direction of the arrow A in FIG. **3**.

FIG. **8** is a plan view illustrating a state in which an IC device is not placed on a test unit disposed in the test region illustrated in FIG. **3**.

FIG. **9** is a partial sectional view when viewed in the direction of the arrow B in FIG. **8**.

FIG. **10** is a plan view illustrating a state in which the IC device is placed on the test unit disposed in the test region illustrated in FIG. **3**.

FIG. **11** is a partial sectional view when viewed in the direction of the arrow C in FIG. **10**.

FIG. **12** is a partial cross-sectional view illustrating a structure of a vertical direction moving mechanism unit included in the electronic component tester illustrated in FIG. **1**.

FIG. **13** is a partial cross-sectional view illustrating a structure of the vertical direction moving mechanism included in the electronic component tester illustrated in FIG. **1**.

FIG. **14** is a partial vertical sectional view illustrating a structure of a turning mechanism unit included in the electronic component tester illustrated in FIG. **1**.

FIG. **15** is a partial vertical sectional view illustrating a structure of the turning mechanism unit included in the electronic component tester illustrated in FIG. **1**.

FIG. **16** is a partial sectional view of the inside of a test region of an electronic component tester (second embodiment) according to the invention when viewed from the front side.

FIG. **17** is a view of the inside of an electronic component tester (third embodiment) according to the invention when viewed from the front side.

FIG. **18** is an enlarged plan view in a test region of an electronic component tester (fourth embodiment) according to the invention.

FIG. **19** is a vertical sectional view illustrating a structure of a light irradiation unit included in an electronic component tester (fifth embodiment) according to the invention.

FIG. **20** is an enlarged plan view of the inside of a test region of the electronic component tester (fifth embodiment) according to the invention.

FIG. **21** is an enlarged plan view of the inside of the test region of the electronic component tester (fifth embodiment) according to the embodiment.

FIG. **22** is an enlarged plan view of the inside of the test region of the electronic component tester (fifth embodiment) according to the invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, an electronic component handler and an electronic component tester according to the invention will be described in detail on the basis of preferred embodiments illustrated in the accompanying drawings.

First Embodiment

Hereinafter, an electronic component handler and an electronic component tester according to a first embodiment of the invention will be described with reference to FIGS. **1** to **15**. Note that three axes that perpendicularly intersect one another will be assumed to be an X axis, a Y axis, and a Z axis below as illustrated in FIG. **1** for convenience of description. An XY plane that includes the X axis and the Y axis is horizontal, and the Z axis is vertical. That is, the Z axis extends on a vertical line. The direction in parallel with the X axis will also be referred to as an "X direction (first direction)", the direction in parallel with the Y axis will also be referred to as a "Y direction (second direction)", and the direction in parallel with the Z axis will also be referred to as a "Z direction (third direction)". Also, the direction in which the arrow in each direction is directed will be referred to as a "positive" side while the direction opposite thereto will be referred to as a "negative side". The "horizontal" state described herein is not limited to a completely horizontal state and also includes a slightly (less than about 50, for example) inclined state relative to the horizontal state as long as transport of an electronic component is not inhibited. Also, the "vertical" state described herein is not limited to a completely vertical state and also includes a slightly (less than about 50, for example) inclined state relative to the vertical state as long as transport of an electronic component is not inhibited. The upper side in FIGS. **1**, **4** to **7**, **9**, and **11** to **15** (the same is true for FIGS. **16**, **17**, and **19**), that is, the positive side in the Z axis direction may be referred to as "upper" or "above" while the lower side, that is, the negative side in the Z axis direction may be referred to as "lower" or "below".

An electronic component handler **10** according to the invention is a handler that has an appearance illustrated in FIG. **1**. As illustrated in FIGS. **3** to **7**, the electronic component handler **10** includes a transport unit **25** that transports an IC device **90** that is an electronic component, a test region A**3** (region) in which a test unit **16** that serves as an electronic component placement unit **26** on which the IC device **90** (electronic component) is placed can be disposed, a light irradiation unit **4** that can irradiate the test unit **16** (electronic component placement unit **26**) with laser light L**41** (light), and a vertical direction moving mechanism unit **6** that movably supports the light irradiation unit **4** such that the position thereof in the Z direction (vertical direction) changes.

In this manner, it is possible to appropriately adjust the position of the light irradiation unit **4** in the Z direction even if the test unit **16** is replaced with one with a recessed portion **161** at a changed position as will be described later. In this manner, it is possible to emit the laser light L**41** from the light irradiation unit **4** regardless of the position of the recessed portion **161**. Also, it is possible to accurately detect remaining of the IC device **90** relative to the recessed portion **161** on the basis of a projection shape of the laser light L**41** on the recessed portion **161**, for example.

Note that although the electronic component placement unit **26** is applied to the test unit **16** in the embodiment, the invention is not limited thereto, and the electronic component placement unit **26** may be applied to temperature adjustment units **12**, device supply units **14**, device collection units **18**, collection trays **19**, or trays **200**, which will be described later.

As illustrated in FIG. **2**, an electronic component tester **1** according to the invention is a test system that includes the electronic component handler **10** and further includes a test unit **16** that tests an electronic component. That is, the electronic component tester **1** includes the transport unit **25** that transports the IC device **90** that is an electronic component, the test unit **16** that has the electronic component placement unit **26** on which the IC device **90** (electronic component) is placed and that can test the IC device **90**

(electronic component) placed on the electronic component placement unit **26**, the test region A**3** (region) in which the test unit **16** can be disposed, the light irradiation unit **4** that can irradiate the test unit **16** (electronic component placement unit **26**) with the laser light L**41** (light), and the vertical direction moving mechanism unit **6** that movably supports the light irradiation unit **4** such that the position thereof in the Z direction (vertical direction) changes.

In this manner, the electronic component tester **1** that has advantages of the aforementioned electronic component handler **10** is obtained. Also, it is possible to transport the IC device **90** to the test unit **16** and to perform test on the IC device **90** by the test unit **16**. In addition, it is possible to transport the IC device **90** after the test from the test unit **16**.

Hereinafter, configurations of the respective parts will be described in detail.

As illustrated in FIGS. **1** and **2**, the electronic component tester **1** that has the electronic component handler **10** is a device that transports an electronic component such as an IC device with a ball grid array (BGA) package, for example, and inspects and tests (hereinafter, simply referred to as "test") electronic properties of the electronic component in the process of the transport. Note that a case in which the IC device is used as the electronic component will be described as a representative case below and this will be assumed to be the "IC device **90**" for convenience of description. The IC device **90** has a flat plate shape in the embodiment.

Examples of the IC device include a "large scale integration (LSI)", a "complementary MOS (CMOS)", a "charge coupled device (CCD)", a "module IC" in which a plurality of modules are packaged as an IC device, a "quartz device", a "pressure sensor", an "inertial sensor (acceleration sensor)", a "gyro sensor", and a "fingerprint sensor" as well as the examples described above.

The electronic component tester **1** (electronic component handler **10**) includes a tray supply region A**1**, a device supply region A**2**, the test region A**3**, a device collection region A**4**, and a tray removal region A**5**, and these regions are sectioned by the respective walls as will be described later. The IC device **90** passes through the respective regions from the tray supply region A**1** to the tray removal region A**5** in order in the direction of the arrow α**90**, and test is performed thereon in the test region A**3** on the way. In this manner, the electronic component tester **1** includes the electronic component handler **10** that has the transport unit **25** for transporting the IC device **90** via the respective regions, the test unit **16** that performs test in the test region A**3**, and a control unit **800**. Also, the electronic component tester **1** includes a monitor **300**, a signal lamp **400**, and an operation panel **700**.

Note that the side on which the tray supply region A**1** and the tray removal region A**5** are disposed in the electronic component tester **1**, that is, a lower side in FIG. **2** is used as the front side while the side on which the test region A**3** is disposed, that is, the upper side in FIG. **2** is used as the rear side.

The electronic component tester **1** is used with components that are replaced depending on each type of the IC device **90**, are called "change kits", and are mounted thereon in advance. The change kits include, for example, the temperature adjustment units **12**, the device supply units **14**, and the device collection units **18**. In addition to such change kits, the trays **200**, the collection trays **19**, and the test unit **16** that a user prepare, for example, are also replaced depending on each type of the IC device **90**.

The tray supply region A**1** is a material feeding portion to which a tray **200** with a plurality of aligned IC devices **90** in an untested state is supplied. The tray supply region A**1** can also be referred to as a placing region in which a plurality of trays **200** can be placed in a piled-up manner. Note that a plurality of recessed portions (pockets) are arranged in a matrix shape in each tray **200** according to the embodiment. It is possible to accommodate and place the IC device **90** one by one in each recessed portion.

The device supply region A**2** is a region through which the plurality of IC devices **90** on the trays **200**, which have been transported from the tray supply region A**1**, are respectively transported and supplied to the test region A**3**. Note that a tray transport mechanism **11**A and a tray transport mechanism **11**B that transport the trays **200** in the horizontal direction one by one are provided such that the tray transport mechanism **11**A and the tray transport mechanism **11**B extend across the tray supply region A**1** and the device supply region A**2**. The tray transport mechanism **11**A is a part of the transport unit **25** and can move the trays **200** on the positive side in the Y direction, that is, in the direction of the arrow α**11**A in FIG. **2** along with the IC devices **90** placed on the trays **200**. In this manner, it is possible to stably feed the IC devices **90** to the device supply region A**2**. Also, the tray transport mechanism **11**B can move vacant trays **200** on the negative side in the Y direction, that is, in the direction of the arrow α**11**B in FIG. **2**. In this manner, it is possible to move the vacant trays **200** from the device supply region A**2** to the tray supply region A**1**.

In the device supply region A**2**, the temperature adjustment unit (soak plate) **12**, a device transport head **13**, and a tray transport mechanism **15** are provided. Also, the device supply units **14** that move across the device supply region A**2** and the test region A**3** is also provided.

The temperature adjustment units **12** are called "soak plates" that are adapted such that the plurality of IC devices **90** are placed thereon and that can collectively heat or cool down the IC devices **90** placed thereon. With this soak plate, it is possible to heat or cool down the IC devices **90** before test performed by the test unit **16** in advance and to adjust a temperature to a temperature suitable for the test (high-temperature test or low-temperature test).

The temperature adjustment units **12** that serve as such placement units are secured. In this manner, it is possible to stably adjust the temperature for the IC devices **90** on the temperature adjustment units **12**.

Also, the temperature adjustment units **12** are grounded.

In the configuration illustrated in FIG. **2**, two temperature adjustment units **12** are disposed and secured in the Y direction. Then, the IC devices **90** on the tray **200**, which has been transported from the tray supply region A**1** by the tray transport mechanism **11**A, is transported to any of the temperature adjustment units **12**.

The device transport head **13** is for gripping the IC devices **90**, is supported such that the device transport head **13** can move in the X direction and the Y direction in the device supply region A**2**, and is further supported such that the device transport head **13** can also move in the Z direction. The device transport head **13** is also a part of the transport unit **25** and can be in charge of transport of the IC devices **90** between the trays **200** that have been transported from the tray supply region A**1** and the temperature adjustment units **12** and transport of the IC devices **90** between the temperature adjustment units **12** and the device supply units **14**, which will be described later. Note that movement of the device transport head **13** in the X direction is represented by the arrow α**13**X while movement of the device transport head **13** in the Y direction is represented by the arrow α**13**Y in FIG. **2**.

The device supply units **14** are called "supply shuttle plates" or simply "supply shuttles" that are adapted such that the IC devices **90** at a temperature adjusted by the temperature adjustment units **12** are placed thereon and that are capable of transporting the IC devices **90** to the vicinity of the test unit **16**. The device supply units **14** can also be a part of the transport unit **25**. The device supply units **14** have recessed portions (pockets) in which the IC devices **90** are accommodated and placed.

The device supply units **14** are supported such that the device supply units **14** can reciprocate (move) in the X direction, that is, the direction of the arrow $\alpha 14$ between the device supply region A**2** and the test region A**3**. In this manner, the device supply units **14** can stably transport the IC devices **90** from the device supply region A2 to the vicinity of the test unit **16** in the test region A**3** and can return to the device supply region A2 again after the IC devise **90** are removed by the device transport heads **17** in the test region A**3**.

In the configuration illustrated in FIG. **2**, two device supply units **14** are disposed in the Y direction, and the device supply unit **14** on the negative side in the Y direction may be referred to as a "device supply unit **14**A" while the device supply unit **14** on the positive side in the Y direction may be referred to as a "device supply unit **14**B". The IC devices **90** on the temperature adjustment units **12** are transported to the device supply unit **14**A or the device supply unit **14**B in the device supply region A**2**. The device supply units **14** are configured to be able to heat or cool down the IC devices **90** placed on the device supply units **14** similarly to the temperature adjustment units **12**. In this manner, it is possible to maintain a temperature adjusted state of the IC devices **90** at a temperature adjusted by the temperature adjustment units **12** and to transport the IC devices **90** to the vicinity of the test unit **16** in the test region A**3**. The device supply units **14** are also grounded similarly to the temperature adjustment units **12**.

The tray transport mechanism **15** is a mechanism that transports the vacant trays **200** in a state in which all the IC devices **90** have been removed therefrom on the positive side in the X direction, that is, the direction of the arrow α**15** in the device supply region A**2**. Then, the vacant trays **200** are returned from the device supply region A**2** to the tray supply region A**1** by the tray transport mechanism **11**B after the transport.

The test region A**3** is a region in which the IC devices **90** are tested. In the test region A**3**, the test unit **16** that tests the IC devices **90** and the device transport heads **17** are provided.

The device transport heads **17** are a part of the transport unit **25** and are configured to be able to heat or cool down the gripped IC devices **90** similarly to the temperature adjustment units **12**. As illustrated in FIGS. **4** to **7**, the device transport heads **17** have gripping units **171** that grip the IC devices **90** (electronic components) through adsorption below the device transport heads **17**. In this manner, it is possible to grip the IC devices **90** maintained in the temperature adjusted state and to transport the IC devices **90** in the test region A**3** while maintaining the temperature adjusted state. Note that the number of gripping units **171** mounted is not limited to the number illustrated in FIGS. **4** to **7**.

Such device transport heads **17** are supported such that the device transport heads **17** can reciprocate in the Y direction and the Z direction in the test region A3 and serves as a part of a mechanism called an "index arm". In this manner, the device transport heads **17** can lift the IC devices **90** from the device supply units **14** that have been transported from the device supply region A**2** and transport and place the IC devices **90** to and on the test unit **16**.

Note that the reciprocation of the device transport heads **17** in the Y direction is represented by the arrow α**17**Y in FIGS. **2** and **3**. As illustrated in FIG. **3**, the device transport heads **17** can be in charge of transport of the IC devices **90** from the device supply unit **14**A to the test unit **16** (see the device transport head **17** represented by the solid line on the upper side and the device transport head **17** represented by the two-dotted chain line at the center in FIG. **3**) and transport of the IC devices **90** from the device supply unit **14**B to the test unit **16** (see the device transport head **17** represented by the two-dotted chain line on the lower side and the device transport head **17** represented by the two-dotted chain line at the center in FIG. **3**) in the test region A**3**. Although the device transport heads **17** are supported such that the device transport heads **17** can reciprocate in the Y direction, the invention is not limited thereto, and the device transport heads **17** may be supported such that the device transport heads **17** can also reciprocate in the X direction.

In the embodiment, two device transport heads **17** are disposed in the Y direction (see FIG. **2**). Hereinafter, the device transport head **17** on the negative side in the Y direction may be referred to as a "device transport head **17**A" while the device transport head **17** on the positive side in the Y direction may be referred to as a "device transport head **17**B". The device transport head **17**A can be in charge of transport of the IC devices **90** from the device supply unit **14**A to the test unit **16** in the test region A**3** while the device transport head **17**B can be in charge of transport of the IC devices **90** from the device supply unit **14**B to the test unit **16** in the test region A**3**. Also, the device transport head **17**A can be in charge of transport of the IC devices **90** from the test unit **16** to the device collection unit **18**A in the test region A**3** while the device transport head **17**B can be in charge of transport from the test unit **16** to the device collection unit **18**B in the test region A**3**.

The test unit **16** (socket) can test electric properties of the IC devices **90** with the IC devices **90** as electronic components placed thereon. As illustrated in FIGS. **3** to **7**, the test unit **16** has recessed portions (pockets) **161** in which the IC devices **90** are accommodated and placed, and a plurality of probe pins (not illustrated) are provided on bottom surfaces **162** of the recessed portions **161**. It is possible to perform test on the IC devices **90** by terminals of the IC devices being connected to the probe pins in a conductive manner, that is, by the terminals of the IC devices **90** being brought into contact with the probe pins. The test of the IC devices **90** is performed on the basis of a program that is stored in an test control unit provided in a tester that is connected to the test unit **16**.

Note that three recessed portions **161** are arranged at intervals in the X direction as illustrated in FIG. **3** in one example of the embodiment, and the recessed portions may be called a "recessed portion **161**A", a "recessed portion **161**B", and a "recessed portion **161**C" in order from the negative side in the X direction. The arrangement mode (the number of arranged recessed portions **161** in the X direction and the number of arranged recessed portions **161** in the Y direction) and the total number of arranged recessed portions **161** are not limited to those illustrated in FIG. **3**.

Such a test unit **16** can heat or cool down the IC devices **90** and adjust the temperature of the IC devices **90** to a temperature suitable for the test similarly to the temperature adjustment units **12**.

The device collection region **A4** is a region in which the plurality of IC devices **90**, which have been tested in the test region A**3** and have completed the test, are collected. In the device collection region A**4**, the collection trays **19**, a device transport head **20**, and a tray transport mechanism **21** are provided. Also, the device collection units **18** that move across the test region A**3** and the device collection region A**4** are also provided. In addition, vacant trays **200** are also prepared in the device collection region A**4**.

The device collection units **18** are called "collection shuttle plates" or simply "collection shuttles" that are adapted such that the IC devices **90** which have completed test using the test unit **16** are placed thereon and that transports the IC devices **90** to the device collection region A**4**. The device collection units **18** can also be a part of the transport unit **25**.

The device collection units **18** are supported such that the device collection units **18** can reciprocate in the X direction, that is, in the direction of the arrow α**18** between the test region A**3** and the device collection region A**4**. In the configuration illustrated in FIG. **2**, two device collection units **18** are disposed in the Y direction similarly to the device supply units **14**, and the device collection unit **18** on the negative side in the Y direction may be referred to as a "device collection unit **18**A" while the device collection unit **18** on the positive side in the Y direction may be referred to as a "device collection unit **18**B. The IC devices **90** on the test unit **16** are transported to the device collection unit **18**A or the device collection unit **18**B and placed thereon. As illustrated in FIG. **3**, the device transport heads **17** can be in charge of transport of the IC devices **90** from the test unit **16** to the device collection unit **18**A (see the device transport head **17** represented by the two-dotted chain line at the center and the device transport head **17** represented by the solid line on the upper side in FIG. **3**) in the test region A**3** and transport of the IC devices **90** from the test unit **16** to the device collection unit **18**B (see the device transport head **17** represented by the two-dotted chain line at the center and the device transport head **17** represented by the two-dotted chain line on the lower side in FIG. **3**). The device collection units **18** are also grounded similarly to the temperature adjustment units **12** and the device supply units **14**.

The collection trays **19** are adapted such that IC devices **90** which have been tested by the test unit **16** are placed thereon and are secured such that the collection tray **19** does not move in the device collection region A**4**. In this manner, the IC devices **90** after the test are stably placed on the collection trays **19** even in the device collection region A**4** in which a relatively large number of various movable portions such as the device transport head **20** are disposed. Note that three collection trays **19** are disposed in the X direction in the configuration illustrated in FIG. **2**.

Three vacant trays **200** are disposed in the X direction. The IC devices **90** that have been tested by the test unit **16** are also placed on the vacant trays **200**. Then, the IC devices **90** on the device collection units **18** that have moved to the device collection region A**4** are transported to and placed on either the collection trays **19** or the vacant trays **200**. In this manner, the IC devices **90** are classified and collected depending on each test result.

The device transport head **20** has a part that is supported such that the part can move in the X direction and the Y direction and can also move in the Z direction in the device collection region A**4**. The device transport head **20** is a part of the transport unit **25** and can transport the IC devices **90** from the device collection units **18** to the collection trays **19** or the vacant trays **200**. Note that movement of the device transport head **20** in the X direction is represented by the arrow α**20**X while movement of the device transport head **20** in the Y direction is represented by the arrow α**20**Y in FIG. **2**.

The tray transport mechanism **21** is a mechanism that transports a vacant tray **200**, which has been transported from the tray removal region A**5**, in the X direction, that is, the direction of the arrow α**21** in the device collection region A**4**. After the transport, the vacant tray **200** is disposed at a position at which the IC devices **90** are collected, that is, the vacant tray **200** can be any one of the three vacant trays **200**.

The tray removal region A**5** is a removing member at which the trays **200** on which the plurality of IC devices **90** in the tested state are aligned are collected and removed. In the tray removal region A**5**, multiple trays **200** can be piled up.

A tray transport mechanism **22**A and a tray transport mechanism **22**B that transport the trays **200** one by one in the Y direction across the device collection region A**4** and the tray removal region A**5**. The tray transport mechanism **22**A is a part of the transport unit **25** and can cause the trays **200** to reciprocate in the Y direction, that is, the direction of the arrow α**22**A. In this manner, it is possible to transport the IC devices **90** after the test from the device collection region A**4** to the tray removal region A**5**. The tray transport mechanism **22**B can move the vacant trays **200** for collecting the IC devices **90** on the positive side in the Y direction, that is, the direction of the arrow α**22**B. In this manner, it is possible to move the vacant trays **200** from the tray removal region A**5** to the device collection region A**4**.

The control unit **800** can control operations of the respective parts, namely, the tray transport mechanism **11**A, the tray transport mechanism **11**B, the temperature adjustment units **12**, the device transport head **13**, the device supply units **14**, the tray transport mechanism **15**, the test unit **16**, the device transport heads **17**, the device collection units **18**, the device transport head **20**, the tray transport mechanism **21**, the tray transport mechanism **22**A, the tray transport mechanism **22**B, and the light irradiation unit **4** and an imaging unit **5** in a remaining detection unit **3**, which will be described later.

An operator can set or check operation conditions of the electronic component tester **1** via the monitor **300**. The monitor **300** has a display screen **301** including a liquid crystal screen, for example, and is arranged above the electronic component tester **1** on the front side. As illustrated in FIG. **1**, a mouse table **600** on which a mouse is placed is provided on the right side of the tray removal region A**5** in the drawing. The mouse is used to operate a screen displayed on the monitor **300**.

An operation panel **700** is disposed below the monitor **300** on the right side in FIG. **1**. The operation panel **700** is provided separately from the monitor **300** and is for providing a command for a desired operation to the electronic component tester **1**.

The signal lamp **400** can provide notifications of operation states or the like of the electronic component tester **1** by combining colors of emitted light. The signal lamp **400** is disposed above the electronic component tester **1**. Note that a speaker **500** is incorporated in the electronic component tester **1** and that it is possible to provide notifications of operation states or the like of the electronic component tester **1** by the speaker **500**.

In the electronic component tester **1**, a first barrier wall **231** sections between the tray supply region A**1** and the device supply region A**2**, a second barrier wall **232** sections between the device supply region A**2** and the test region A**3**,

a third barrier wall **233** sections between the test region A**3** and the device collection region A**4**, and a fourth barrier wall **234** sections between the device collection region A**4** and the tray removal region A**5**. A fifth barrier wall **235** also sections between the device supply region A**2** and the device collection region A**4**.

The outermost exterior of the electronic component tester **1** is covered with covers, and the covers include, for example, a front cover **241**, a side cover **242**, a side cover **243**, a rear cover **244**, and a top cover **245**.

As described above, the test unit **16** that can perform test with the IC devices **90** placed thereon is disposed in the test region A**3**. According to the electronic component tester **1**, it is detected whether or not there are IC devices **90** in the recessed portions **161** in the test unit **16**, that is, remaining of the IC devices **90** before test when the test of the IC devices **90** is performed with the test unit **16**. The remaining is detected for the following reason, for example.

In a case in which the IC devices **90** remain in the recessed portions **161** of the test unit **16** (hereinafter, the IC devices **90** will be referred to as "remaining devices"), next IC devices **90** to be tested in the recessed portions **161** (hereinafter, the IC devices **90** will be referred to as "untested devices") are placed such that the IC devices **90** are overlaid on the remaining devices. There is a concern that it becomes difficult to accurately perform test on the untested devices in such a state. Therefore, it is preferable that the test unit **16** detects remaining of the IC devices **90**.

Thus, the electronic component tester **1** includes the remaining detection unit **3** that detects remaining of the IC devices **90** in the test unit **16**. As illustrated in FIGS. **3** to **7**, the remaining detection unit **3** has a light irradiation unit (illumination unit) **4** that illuminates the test unit **16** and the imaging unit **5** that images the test unit **16** illuminated by the light irradiation unit **4**.

As illustrated in FIG. **4** (the same is true for FIGS. **5** to **7**), the light irradiation unit **4** is disposed on an obliquely left upper side relative to the test unit **16**, that is, on the negative side in the X direction and on the positive side in the Z direction relative to the test unit **16**. The light irradiation unit **4** is a light source unit that has three (a plurality of) laser light sources **41** in the embodiment. These laser light sources **41** are disposed at intervals in the Z direction and may be referred to as a "light source **41**A", a "laser light source **41**B", and a "laser light source **41**C" I order from the negative side in the Z direction. Note that the laser light sources **41** are not particularly limited, and semiconductor laser light sources or another type of laser light sources can be used, for example. In a case in which a plurality of laser light sources **41** are provided, the arrangement thereof is not limited to alignment in the Z direction, and the plurality of laser light sources **41** may be aligned in any of the X direction, the Y direction, and the Z direction.

The laser light source **41**A can irradiate the recessed portion **161**A of the test unit **16** with the laser light L**41** that serves as slit light in the Y direction.

The laser light source **41**B can irradiate the recessed portion **161**B of the test unit **16** with the laser light L**41** that serves as slit light in the Y direction.

The laser light source **41**C can irradiate the recessed portion **161**C of the test unit **16** with the laser light L**41** that serves as slit light in the Y direction.

Note that it is possible to use laser light sources that have cylindrical lenses, for example, as the respective laser light sources **41**. In this manner, the projection shape of the laser light L**41** on the test unit **16** becomes a linear shape. Also, laser light sources that scan spot light in the Y direction, for example, may be used as the respective laser light sources **41** rather than the aforementioned laser light sources.

In addition, it is preferable that the number of laser light sources **41** disposed is equal to or greater than the number of recessed portions **161** arranged in the X direction. Although the number of laser light sources **41** disposed is three in the embodiment, the number is not limited thereto and may be one, two, four, or more, for example.

Although the locations at which the laser light sources **41** (the light irradiation unit **4**) are arranged are the obliquely left upper side in the drawing relative to the test unit **16** in the configuration illustrated in FIG. **4**, the locations are not limited thereto and may be an obliquely right upper side or both the obliquely left upper side and the obliquely right upper side, for example.

As illustrated in FIG. **4**, the imaging unit **5** is disposed and secured above the test unit **16**, that is, on the positive side in the Z direction relative to the test unit **16**. As illustrated in FIG. **3**, the imaging unit **5** includes four cameras **51** in the embodiment. Two of these cameras **51** are disposed in the X direction, the other two are disposed in the Y direction and both have different imaging ranges. It is possible to obtain an image of the entire test unit **16** by synthesizing images captured by the respective cameras **51**.

Note that the respective cameras **51** are not particularly limited, and charge-coupled device (CCD) cameras, three-dimensional cameras, or the like can be used, for example.

Although the number of cameras **51** disposed is four in the embodiment, the number is not limited thereto and may be one, two, three, five, or more, for example. Also, the arrangement mode (the number of cameras **51** disposed in the X direction and the number of cameras **51** disposed in the Y direction) of the cameras **51** is not limited to that illustrated in FIG. **3**.

Although the respective cameras **51** are secured in the embodiment, the cameras **51** are not limited thereto and may be supported such that the cameras **51** can turn, for example. In this manner, it is possible to change the imaging ranges of the respective cameras **51** or to minimize the total number of cameras **51** disposed.

Processing of detecting remaining of the IC devices **90** in the respective recessed portions **161** of the test unit **16**, that is, processing of determining whether or not the IC devices **90** (electronic components) are present is performed by the control unit **800**. The control unit **800** that serves as the processing unit has at least one processor, and the processor reads various instructions, determinations, commands, and the like stored in the control unit **800** and performs the various instructions, various determinations, various orders, and the like. The control unit **800** (processor) can perform the remaining detection processing on the basis of at least one of the projection shape and the irradiation position of the laser light L**41** projected on the test unit **16** by the test unit **16**. Hereinafter, the processing will be described with reference to FIGS. **8** to **11**. FIGS. **8** to **11** illustrate one recessed portion **161** as a representative and laser light L**41** with which the recessed portion **161** is irradiated.

In a state in which the IC devices **90** are not placed in the recessed portions **161** as illustrated in FIGS. **8** and **9**, the laser light L**41** reaches the bottom surfaces **162** of the recessed portions **161**. The projection shape of the laser light L**41** on the test unit **16** at this time is a linear shape (line shape) that is bent as illustrated in FIG. **8** (see the portion surrounded by the two-dotted chain line in FIG. **8**). The projection shape of the laser light L**41** illustrated in FIG. **8** is imaged by the imaging unit **5** and is stored in advance in the storage unit of the control unit **800**.

Meanwhile, in a state in which the IC devices **90** are placed in the recessed portions **161** as illustrated in FIGS. **10** and **11**, the laser light L**41** reaches upper surfaces **901** of the IC devices **90** in the recessed portion **161** without reaching the bottom surfaces **162** of the recessed portions **161**. The projection shape of the laser light L**41** on the test unit **16** at this time is different from the projection shape of the laser light L**41** illustrated in FIG. **8** in accordance with placement of the IC devices **90** in the recessed portions **161** and forms a linear shape that is bent as illustrated in FIG. **10** (see the portion surrounded by the two-dotted chain line in FIG. **10**). The projection shape of the laser light L**41** illustrated in FIG. **10** is imaged as an image by the imaging unit **5** and is stored in advance in the storage unit of the control unit **800**.

In a case in which the remaining detection is performed in practice, the recessed portions **161** to which the remaining detection is to be performed is irradiated with the laser light L**41**, and the projection shape of the laser light L**41** is imaged by the imaging unit **5**. Then, the projection shape of the laser light L**41** projected on the recessed portions **161** on which remaining detection is to be performed is compared to find which of the projection shape of the laser light L**41** illustrated in FIG. **8** and the projection shape of the laser light L**41** illustrated in FIG. **10** the projection shape is approximated to, and it is then determined whether or not the IC devices **90** remain. Note that although the method of comparing the projection shapes of the laser light L**41** as described above is employed as a method of determining whether or not the IC devices **90** remain in the embodiment, the invention is not limited thereto.

As described above, the light irradiation unit **4** has the plurality of laser light sources **41** that serve as light sources and emit the laser light L**41** (light) in the remaining detection unit **3**. Also, the electronic component tester **1** (electronic component handler **10**) has a configuration including the imaging unit **5** that images the test unit **16** (electronic component placement unit **26**). With such a configuration, it is possible to irradiate the respective recessed portions **161** of the test unit **16** with the laser light L**41** from the respective laser light sources **41**. Then, it is possible to image the projection shapes of the laser light L**41** projected on the respective recessed portions **161** with the imaging unit **5** and to accurately determine whether or not the IC devices **90** remain in the respective recessed portions **161** in accordance with a result of the image capturing. Note that the light sources are not limited to the laser light sources **41** and may be another type of light sources, such as various lamps or LEDs, for example.

Incidentally, the number or recessed portions **161** arranged, the arrangement mode (pitches between the recessed portions **161** arranged in the X direction or the like), the depth of the recessed portions **161**, or the like may differ in the test unit **16** depending on the type of the IC devices **90**, for example. In this case, it is necessary to adjust the positions (height) and the postures (angles) of the respective laser light sources **41** of the light irradiation unit **4** (see FIGS. **4** to **7**). Hereinafter, the adjustment will be described. Note that the adjustment is performed prior to the processing of detecting remaining of the IC devices **90** performed by the test unit **16** (processing of determining whether or not the IC devices **90** are present). In this manner, it is possible to accurately detect whether or not the IC devices **90** remain in the recessed portions **161** of the test unit **16** even in a case in which the test unit **16** has been replaced in accordance with the type of the IC device **90**.

Note that it is preferable that the irradiation positions of the laser light L**41** on the test unit **16** are adjusted to fall within regions B**1** inside the recessed portions **161** and that it is more preferable that the irradiation positions are adjusted to be at centers O**162** of the bottom surfaces **162** of the recessed portions **161** in the X direction, in particular, in the regions B**1** (see FIGS. **9** and **11**). Although the length of the regions B**1** in the X direction is not particularly limited, it is preferable that the length is equal to or greater than 1% and equal to or less than 10%, and it is more preferable that the length is equal to or greater than 5% and equal to or less than 10% of the length of each IC device **90** accommodated in each recessed portion **161** in the X direction.

As described above, the laser light L**41** is slit light, and the projection shape thereof is a bent linear shape (see FIGS. **8** and **10**). In this case, a center line M**41** of the linear shape in the width direction is assumed to be the irradiation position of the laser light L**41**. In this manner, it is possible to decide the irradiation position irrespective of how wide the slit light is on the test unit **16**.

Note that the width of the slit light on the test unit **16** is preferably equal to or greater than 0.3 mm and equal to or less than 1 mm and is more preferably equal to or greater than 0.3 mm and equal to or less than 0.5 mm.

A method of detecting the center line M**41** is not particularly limited, and for example, a method of detecting (measuring) luminance distribution of the slit light on the test unit **16** and setting a portion with the highest luminance as the center line M**41** is exemplified.

Although the center line M**41** in the width direction of the line shape is set as the irradiation position of the laser light L**41**, the invention is not limited thereto. In a case in which the size of the recessed portions **161** in a plan view is sufficiently large relative to the width of the linear shape, for example, the entire linear shape in the width direction may be set as the irradiation position of the laser light L**41**.

As illustrated in FIGS. **3** to **7**, the remaining detection unit **3** (electronic component handler **10**) includes the vertical direction moving mechanism unit **6** that movably supports the respective laser light sources **41** of the light irradiation unit **4** such that the laser light sources **41** can move in the Z direction (vertical direction) and a turning mechanism unit **7** that supports the respective laser light sources **41** such that the laser light sources **41** can turn about a turning axis O**41** in parallel with the Y axis.

As illustrated in FIGS. **12** and **13**, the vertical direction moving mechanism unit **6** has a guide rail **61** that serve as a guide, that guides the respective laser light sources **41** of the light irradiation unit **4** in the Z direction (vertical direction), sliders **62** that serve as a first support unit, a second support unit, and the like, support the respective laser light sources **41**, and slide on the guide rail **61**, and a movement adjustment unit **63** that restricts sliding of the respective sliders **62** and adjusts the positions thereof. The guide may be a groove that guides the respective laser light sources **41** of the light irradiation unit **4** in the Z direction. Further, the guide may be a screw shaft of a ball screw.

The guide rail **61** is disposed in parallel with the Z direction. The guide rail **61** is secured to the second barrier wall **232**, for example, in the test region A**3** by a securing method such as a method using screwing. By providing such a guide rail **61**, it is possible to cause the respective sliders **62** to smoothly slide along the guide rail **61**, and it is thus possible to accurately perform adjustment of the positions of the laser light sources **41**, which are supported by the respective sliders **62**, in the Z direction, that is, adjustment of the height H**41**A of the laser light source **41**A from the bottom surface **162** of the recessed portion **161**, adjustment of the height H**41**B of the laser light source **41**B, and

adjustment of the height H**41**C of the laser light source **41**C. Note that the guide rail **61** may be provided in an inclined manner relative to the Z direction.

As illustrated in FIGS. **12** and **13**, the sliders **62** are arranged on the positive side of the guide rail **61** in the X direction. Note that the sliders **62** are prevented from coming off from the guide rail **61**. Each slider **62** is formed of a block body that has a first site **621** that faces the positive side in the X direction, a second site **622** that faces the positive side in the Y direction, and a third site **623** that faces the negative side in the Y direction. The laser light sources **41** are supported at the first site **621** of the slider **62**. In this manner, it is possible to cause the slider **62** to slide in the upper-lower direction along the guide rail **61** for each laser light source **41**. It is possible to adjust the positions of the respective laser light sources **41** in the Z direction in a stepless manner through the sliding. Note that although the positions of the respective laser light sources **41** in the Z direction can be adjusted in the stepless manner, the invention is not limited thereto, and the positions may be able to be adjusted in multiple steps.

As illustrated in FIGS. **4** to **7**, the laser light sources **41** are supported by the sliders **62** one by one. In this manner, the vertical direction moving mechanism unit **6** is configured to independently movably support the respective laser light sources **41**. With such a configuration, it is possible to independently perform the adjustment of the height H**41**A of the laser light source **41**A, the adjustment of the height H**41**B of the laser light source **41**B, and the adjustment of the height H**41**C of the laser light source **41**C. In this manner, it is possible to irradiate the target recessed portion **161**A with the laser light L**41** emitted from the laser light source **41**A. Similarly, it is possible to irradiate the target recessed portion **161**B with the laser light L**41** emitted from the laser light source **41**B. Also, it is possible to irradiate the target recessed portion **161**C with the laser light L**41** emitted from the laser light source **41**C.

The vertical direction moving mechanism unit **6** has the movement adjustment unit **63** that adjust the positions of the respective laser light sources **41** (the light irradiation unit **4**) at the destinations of movement when movement of the respective laser light sources **41** of the light irradiation unit **4** in the upper-lower direction stops. In this manner, the respective laser light source **41** can maintain constant irradiation positions relative to the test unit **16**. That is, the laser light source **41**A can continue to irradiate the recessed portion **161**A with the laser light L**41**. Similarly, the laser light source **41**B can continue to irradiate the recessed portion **161**B with the laser light L**41**. The laser light source **41**C can continue to irradiate the recessed portion **161**C with the laser light L**41**.

As illustrated in FIGS. **12** and **13**, the movement adjustment unit **63** has a stopper **64** that can approach and separate from the guide rail **61** and a knurled screw **65** that serves as an operation unit for performing approaching and separating operations of the stopper **64**.

The stopper **64** has an inner portion (brake portion) **641** that is inserted between the guide rail **61** and the second site **622** of each slider **62**, an outer portion **642** that is disposed on the side opposite to the inner portion **641** via the second site **622**, and a coupling portion **643** that couples the inner portion **641** to the outer portion **642**.

The knurled screw **65** has a male screw portion **651** that is supported at the inner portion **641** of the stopper **64** such that the male screw portion **651** can turn and a pinching portion **652** that serves as a screw head. The male screw portion **651** is fit into a female screw portion **624** formed at the second site **622** of each slider **62**. Also, the male screw portion **651** penetrates through a through-hole **644** formed at the outer portion **642** of the stopper **64**.

It is possible to fasten the knurled screw **65** toward the guide rail **61** by pinching the pinching portion **652** of the knurled screw **65** with finger tips and performing a rotation direction directly in a predetermined direction. In this manner, it is possible to press the inner portion **641** of the stopper **64** against the guide rail **61** and thereby to achieve the state illustrated in FIG. **12**. In the state illustrated in FIG. **12**, positional deviation of the laser light sources **41** is prevented, that is, it is possible to adjust the positions of the laser light sources **41**.

It is possible to loosen the knurled screw **65** by performing a rotating operation on the knurled screw **65** in the direction opposite to the aforementioned direction from the state illustrated in FIG. **12**. In this manner, it is possible to cause the inner portion **641** of the stopper **64** to separate from the guide rail **61** and thereby to achieve the state illustrated in FIG. **13**. In the state illustrated in FIG. **13**, positional restriction of the laser light sources **41** is released. In this manner, it is possible to adjust the positions (adjust the heights) of the laser light sources **41** by causing each slider **62** to slide along the guide rail **61** for each laser light source **41**.

Note that the movement adjustment unit **63** is not limited to the one with the configuration illustrated in FIGS. **12** and **13**.

Although the positions of the laser light sources **41** is manually adjusted in the embodiment, the invention is not limited thereto, and the position adjustment may be automated by supplying electric power, for example.

As described above, the remaining detection unit **3** (electronic component handler **10**) includes the turning mechanism unit **7** that supports the respective laser light sources **41** of the light irradiation unit **4** such that the laser light sources **41** can turn about the turning axis O**41** in parallel with the Y axis. In this manner, it is possible to smoothly perform adjustment of the postures of the laser light sources **41** relative to the Z direction (the inclination angle of the optical axis of the laser light L**41**), that is, a turning angle θ**41**A of the laser light source **41**A, adjustment of a turning angle θ**41**B of the laser light source **41**B, and adjustment of a turning angle θ**41**C of the laser light source **41**C. Thus, it is possible to accurately irradiate the recessed portions **161** as irradiation targets with the laser light L**41** in conjunction with the adjustment of the heights of the laser light sources **41**.

As described above, the light irradiation unit **4** has the plurality of laser light sources **41** that emit the laser light L**41**. As illustrated in FIGS. **4** to **7**, the turning mechanism unit **7** supports the laser light sources **41** one by one such that the laser light sources **41** can turn. In this manner, the turning mechanism unit **7** is configured to support the respective laser light sources **41** such that the laser light sources **41** can independently turn. With such a configuration, it is possible to independently perform the adjustment of the turning angle θ**41**A of the laser light source **41**A, the adjustment of the turning angle θ**41**B of the laser light source **41**B, and the adjustment of the turning angle θ**41**C of the laser light source **41**C. In this manner, it is possible to irradiate the target recessed portion **161**A with the laser light L**41** emitted from the laser light source **41**A. Similarly, it is possible to irradiate the target recessed portion **161**B with the laser light L**41** emitted from the laser light source **41**B. Also, it is possible to irradiate the target recessed portion **161**C with the laser light L**41** emitted from the laser light source **41**C.

As illustrated in FIGS. **14** and **15**, the turning mechanism unit **7** has a decelerator **71** that decelerates angular speeds of the respective laser light sources **41** of the light irradiation unit **4**. The decelerator **71** includes a first gear **711**, a second gear **712** that is meshed with the first gear **711**, and a lever **713** that is detachable with respect to the first gear **711**.

The first gear **711** is formed of a spur gear. The lever **713** can be detachably attached to a shaft member **714** that rotatably supports the first gear **711**. It is possible to rotate the first gear **711** in the same direction by performing a rotating operation on the lever **713** in the same direction in this attached state.

The second gear **712** is also formed of a spur gear, and the diameter thereof is greater than the diameter of the first gear **711**. Note that a deceleration ratio between the first gear **711** and the second gear **712** is arbitrary and is not particularly limited. The shaft member **715** that rotatably supports the second gear **712** is consistent with the turning axis O**41** of the laser light source **41**.

With the turning mechanism unit **7** with such a configuration, it is possible to respectively perform fine adjustment of the turning angle θ**41**A of the laser light source **41**A, fine adjustment of the turning angle θ**41**B of the laser light source **41**B, and fine adjustment of the turning angle θ**41**C of the laser light source **41**C.

Note that the decelerator **71** is not limited to the one with the configuration illustrated in FIGS. **14** and **15**.

The turning mechanism unit **7** has the turning adjustment unit **72** that adjusts the positions of the respective laser light sources **41** (light irradiation unit **4**) at destinations of turning when the turning of the respective laser light sources **41** of the light irradiation unit **4** is stopped. In this manner, the respective laser light sources **41** can maintain constant irradiation positions relative to the test unit **16** along with the movement adjustment unit **63** of the vertical direction moving mechanism unit **6**.

As illustrated in FIGS. **14** and **15**, the turning adjustment unit **72** is formed of a member that moves in the Z direction and is supported such that the turning adjustment unit **72** can approach and separate from the lever **713**. The turning adjustment unit **72** has a groove (recessed portion) **721** formed in a lower surface thereof.

As illustrated in FIG. **14**, the lever **713** is inserted into and engaged with the groove **721** in a state in which the turning adjustment unit **72** has approached the lever **713**. In this manner, it is possible to maintain the postures of the laser light sources **41** by restricting turning of the laser light sources **41** along with the lever **713**.

The state illustrated in FIG. **15**, that is, the state in which the turning adjustment unit **72** has separated from the lever **713** is achieved by moving the turning adjustment unit **72** upward from the state illustrated in FIG. **14**. In the state illustrated in FIG. **15**, the lever **713** has been pulled out of the groove **721**, and the engagement between the lever **713** and the groove **721** has been released. In this manner, it is possible to perform a rotating operation on the lever **713** and thereby to adjust the postures of the laser light sources **41**. Also, it is possible to cause the lever **713** to be engaged with the groove **721** of the turning adjustment unit **72** again after the adjustment. In this manner, it is possible to maintain the postures of the laser light sources **41**.

Note that in a case in which the lever **713** has not achieved the state illustrated in FIGS. **14** and **15**, that is, the state in which the lever **713** projects toward the turning adjustment unit **72** (upper side), and in a case in which it is difficult to establish engagement with the turning adjustment unit **72**, it is possible to cause the lever **713** to come off from the shaft member **714** of the first gear **711** once and to obtain the state in which it is possible to attach the lever **713** to the shaft member **714** again as the state in which it is possible to establish engagement with the turning adjustment unit **72**, and to as illustrated in FIGS. **14** and **15**.

Although the postures of the laser light sources **41** are manually adjusted in the embodiment, the invention is not limited thereto, and the posture adjustment may be automated by supplying electric power, for example.

As described above, the pitches between the recessed portions **161** arranged in the X direction, the depth of the recessed portions **161**, and the like of the test unit **16** may differ depending on the type of the IC devices **90**, for example. In this case, the position adjustment of the respective laser light sources **41** in the Z direction and the posture adjustment about the turning axis O**41** are performed, thereby accurately irradiating the respective recessed portions **161** with the laser light L**41**.

Hereinafter, the adjustment will be described with reference to FIGS. **4** to **7**. Here, the test unit **16** in FIG. **4** will be referred to as an "test unit **16**A", the test unit **16** in FIG. **5** will be referred to as an "test unit **16**B, the test unit **16** in FIG. **6** will be referred to as an "test unit **16**C", and the test unit **16** in FIG. **7** will be referred to as an "test unit **16**D". A case in which the test unit **16**A is replaced with the test unit **16**B (hereinafter, referred to as "first replacement") and a case in which the test unit **16**A is replaced with the test unit **16**C (hereinafter, referred to as "second replacement"), and a case in which the test unit **16**C is replaced with the test unit **16**D (hereinafter, referred to as "third replacement") will be respectively described as examples.

First, the first replacement will be described with reference to FIGS. **4** and **5**.

The pitches between the recessed portions **161** of the test unit **16**A in the X direction are the same as the pitches of the recessed portions **161** of the test unit **16**B in the X direction. The depths of the respective recessed portions **161** of the test unit **16**A are different from the depths of the respective recessed portions **161** of the test unit **16**B, and the depths of the respective recessed portions **161** of the test unit **16**B are shallower than the depths of the respective recessed portions **161** of the test unit **16**A. In a case in which the depths of the recessed portions **161** are shallow, it is preferable to lower the respective heights of the laser light source **41**A, the laser light source **41**B, and the laser light sources **41**C. This is because a state in which the projection shape is bent (see FIG. **8**) significantly appears when the laser light L**41** is projected from the respective laser light sources **41** to the test unit **16**B.

In the state illustrated in FIG. **4**, the recessed portion **161**A is irradiated with the laser light L**41** from the laser light source **41**A, the recessed portion **161**B is irradiated with the laser light L**41** from the laser light source **41**B, and the recessed portion **161**C is irradiated with the laser light L**41** from the laser light source **41**C.

Then, the test unit **16**A is replaced with the test unit **16**B from the state illustrated in FIG. **4**.

Then, the vertical direction moving mechanism unit **6** is operated as described above, the laser light source **41**A, the laser light source **41**B, and the laser light source **41**C are respectively lowered as illustrated in FIG. **5**, thereby performing adjustment of the height H**41**A of the laser light source **41**A, adjustment of the height H**41**B of the laser light source **41**B, and adjustment of the height H**41**C of the laser light source **41**C. Note that the pitch (interval) between the laser light source **41**A and the laser light source **41**B in the Z direction and the pitch (interval) between the laser light

source **41**B and the laser light source **41**C in the Z direction are maintained to be constant even if the state illustrated in FIG. **4** is changed to the state illustrated in FIG. **5**.

As described above, the turning mechanism unit **7** is operated, thereby performing adjustment of the turning angle θ**41**A of the laser light source **41**A, adjustment of the turning angle θ**41**B of the laser light source **41**B, and adjustment of the turning angle θ**41**C of the laser light source **41**C as illustrated in FIG. **5**.

Through such adjustment, the recessed portion **161**A of the test unit **16**B can be irradiated with the laser light L**41** from the laser light source **41**A, the recessed portion **161**B can be irradiated with the laser light L**41** from the laser light source **41**B, and the recessed portion **161**C can be irradiated with the laser light L**41** from the laser light source **41**C even after the replacement of the test unit **16**A with the test unit **16**B.

Next, the second replacement will be described with reference to FIGS. **4** and **6**.

The pitches between the recessed portions **161** of the test unit **16**A in the X direction are the same as the pitches between the recessed portions **161** of the test unit **16**C in the X direction. Also, the depths of the respective recessed portions **161** of the test unit **16**A are different from the depths of the respective recessed portions **161** of the test unit **16**C, and the depths of the respective recessed portions **161** of the test unit **16**C are shallower than the depths of the respective recessed portions **161** of the test unit **16**A.

The state illustrated in FIG. **4** is as described above in regard to the first replacement.

Then, the test unit **16**A is replaced with the test unit **16**C from the state illustrated in FIG. **4**.

Then, the vertical direction moving mechanism unit **6** is operated as described above, and the laser light source **41**A, the laser light source **41**B, and the laser light source **41**C are respectively lowered as illustrated in FIG. **6**, thereby performing adjustment of the height H**41**A of the laser light source **41**A, adjustment of the height H**41**B of the laser light source **41**B, and adjustment of the height H**41**C of the laser light source **41**C.

Also, the turning mechanism unit **7** is operated as described above, thereby performing adjustment of the turning angle θ**41**A of the laser light source **41**A, adjustment of the turning angle θ**41**B of the laser light source **41**B, and adjustment of the turning angle θ**41**C of the laser light source **41**C as illustrated in FIG. **6**. Through the adjustment, it is possible to set the turning angle θ**41**A, the turning angle θ**41**B, and the turning angle θ**41**C to be the same size. Therefore, such adjustment is effective in a case in which it is desirable to achieve a condition of "the turning angle θ**41**A=the turning angle θ**41**B=the turning angle θ**41**C".

Through such adjustment, the recessed portion **161**A of the test unit **16**C can be irradiated with the laser light L**41** from the laser light source **41**A, the recessed portion **161**B can be irradiated with the laser light L**41** from the laser light source **41**B, and the recessed portion **161**C can be irradiated with the laser light L**41** from the laser light source **41**C even after the replacement of the test unit **16**A with the test unit **16**C.

Next, the third replacement will be described with reference to FIGS. **6** and **7**.

The pitches between the recessed portions **161** of the test unit **16**C in the X direction are different from the pitches between the recessed portions **161** of the test unit **16**D in the X direction, and the pitches of the recessed portions **161** of the test unit **16**D in the X direction are shallower than the pitches between the recessed portions **161** of the test unit **16**C in the X direction. Note that the position of the recessed portion **161**B of the test unit **16**C in the X direction is the same as the position of the recessed portion **161**B of the test unit **16**D in the X direction. Also, the depths of the respective recessed portions **161** of the test unit **16**C are the same as the depths of the respective recessed portions **161** of the test unit **16**D.

The state illustrated in FIG. **6** is as described above in regard to the second replacement.

Then, the test unit **16**C is replaced with the test unit **16**D from the state illustrated in FIG. **6**.

Then, the vertical direction moving mechanism unit **6** is operated as described above, and the laser light source **41**A is lifted while the turning angle θ**41**A of the laser light source **41**A is maintained to be constant as illustrated in FIG. **7**, thereby performing adjustment of the height H**41**A of the laser light source **41**A. Similarly, the laser light source **41**C is lowered while the turning angle θ**41**C of the laser light source **41**C is maintained to be constant, thereby performing adjustment of the height H**41**A of the laser light source **41**A and adjustment of the height H**41**C of the laser light source **41**C.

Since the position of the recessed portion **161**B of the test unit **16**C in the X direction is the same as the position of the recessed portion **161**B of the test unit **16**D in the X direction, adjustment of the height H**41**B of the laser light source **41**B can be omitted.

Through such adjustment, the recessed portion **161** A of the test unit **16**D can be irradiated with the laser light L**41** from the laser light source **41**A, the recessed portion **161**B can be irradiated with the laser light L**41** from the laser light source **41**B, and the recessed portion **161**C can be irradiated with the laser light L**41** from the laser light source **41**C even after the replacement of the test unit **16**C with the test unit **16**D.

As described above, it is possible to appropriately adjust the positions of the respective laser light sources **41** in the Z direction and the postures thereof about the turning axis O**41** according to the electronic component tester **1** (electronic component handler **10**) even if the positions of the recessed portions **161** of the test unit **16** are changed. In this manner, it is possible to accurately irradiate the target recessed portions **161** with the laser light L**41** emitted from the respective laser light sources **41** irrespective of the positions of the recessed portions **161**. Then it is possible to accurately detect remaining of the IC devices **90** in the recessed portions **161** on the basis of the projection shape of the laser light L**41** on the recessed portions **161**.

Second Embodiment

Hereinafter, although an electronic component handler and an electronic component tester according to a second embodiment of the invention will be described with reference to FIG. **16**, differences from the aforementioned embodiment will be mainly described, and description of similar matters will be omitted.

The embodiment is similar to the first embodiment other than that the positions of the recessed portions that are targets of laser light sources are different.

As illustrated in FIG. **16**, the respective laser light sources **41** are disposed in the Z direction (vertical direction). These laser light sources **41** are used such that angles of the laser light sources **41** in the Z direction (vertical direction) decrease as the laser light sources **41** are located further upward. That is, the turning angle θ**41**C of the laser light source **41**C located on the uppermost side is the smallest, the

turning angle θ**41**A of the laser light source **41**A located on the lowermost side is the largest, and the turning angle θ**41**B of the laser light source **41**B located between the laser light source **41**A and the laser light source **41**C is the angle with the intermediate size.

In a case in which the recessed portion **161**A is irradiated with the laser light L**41** from the laser light source **41**A, there is a concern that the laser light L**41** is interrupted by a cover member **27** that covers a predetermined mechanism, for example, and does not reach the recessed portion **161**A. In this case, the recessed portion **161**C can be irradiated with the laser light L**41** from the laser light source **41**A, the recessed portion **161**B can be irradiated with the laser light L**41** from the laser light source **41**B, and the recessed portion **161**A can be irradiated with the laser light L**41** from the laser light source **41**C as illustrated in FIG. **16** by employing the aforementioned use mode. In this manner, it is possible to accurately detect remaining of the IC devices **90** in the respective recessed portions **161** on the basis of the projection shapes of the laser light L**41** on the respective recessed portions **161**. Also, it is possible to freely design layout of the respective members in the test region A**3**.

Third Embodiment

Although an electronic component handler and an electronic component tester according to a third embodiment of the invention will be described below with reference to FIG. **17**, differences from the aforementioned embodiments will be mainly described, and description of similar matters will be omitted.

The embodiment is similar to the aforementioned first embodiment other than that the configuration of the vertical direction moving mechanism unit is different.

As illustrated in FIG. **17**, the vertical direction moving mechanism unit **6** has one slider **62** that serves as a support unit. Then, the light irradiation unit **4** forms the light source unit **40** in which a plurality of (three in the embodiment) laser light sources **41** are integrated as a unit and is supported by the slider **62**. That is, the slider **62** that serves as the support unit supports the plurality of laser light sources **41**. In this manner, the vertical direction moving mechanism unit **6** is configured to collectively support the respective laser light sources **41**, that is, to support the respective laser light sources **41** with the entire light source unit **40** such that the laser light sources **41** can move in the same direction. With such a configuration, it may become easier to adjust the heights of the respective laser light sources **41** depending on the type of the test unit **16** disposed in the test region A**3**, for example.

The vertical direction moving mechanism unit **6** has a decelerator **66** that decelerates the moving speed of the light source unit **40** (light irradiation unit **4**). The decelerator **66** has a cylindrical worm **661** that is disposed in parallel with the Z direction and has both ends supported such that the cylindrical worm **661** can turn and a cylindrical worm wheel **662** that is supported by the slider **62** such that the cylindrical worm wheel **662** can turn and is meshed with the cylindrical worm **661**. Note that the deceleration ratio between the cylindrical worm **661** and the cylindrical worm wheel **662** is arbitrary and is not particularly limited.

A lever **663** is provided above the cylindrical worm **661**. The cylindrical worm **661** rotates in the same direction by performing a rotating operation on the lever **663** in the same direction. The rotation force is delivered to the cylindrical worm wheel **662**, and the cylindrical worm wheel **662** rotates by the amount of deceleration. In this manner, the light source unit **40** is lifted or lowered. With the decelerator **66** with such a configuration, it is possible to finely adjust the height of the light source unit **40**. It is possible to easily adjust the positions and the like of the laser light sources **41** by the positions at which the IC devices **90** are placed being irradiated with the slit light (laser light L**41**) from the laser light sources **41**.

Note that the decelerator **66** is not limited to one with the configuration illustrated in FIG. **17**.

Fourth Embodiment

Hereinafter, an electronic component handler and an electronic component tester according to a fourth embodiment of the invention will be described with reference to FIG. **18**, differences from the aforementioned embodiments will be mainly described, and description of similar matters will be omitted.

The embodiment is similar to the aforementioned first embodiment other than the configuration of the remaining detection unit **3** is different.

The remaining detection unit **3** (electronic component handler **10**) includes a horizontal direction moving mechanism unit **8** that supports the light irradiation unit **4** such that the light irradiation unit **4** can move in the XY plane direction (horizontal direction). Note that although the horizontal direction moving mechanism unit **8** is configured to move the light irradiation unit **4** in the Y direction in the embodiment, the horizontal direction moving mechanism unit **8** is not limited thereto and may be configured to move the light irradiation unit **4** in the X direction or to move the light irradiation unit **4** both in the X direction and in the Y direction, for example. In this manner, it is possible to adjust the position of the light irradiation unit **4** in the XY plane direction in accordance with the layout of the recessed portions **161** of the test unit **16**. Through the adjustment, it is possible to accurately irradiate the target recessed portions **161** with the laser light L**41** emitted from the respective laser light sources **41**.

Note that the configuration of the horizontal direction moving mechanism unit **8** is not particularly limited and may have a configuration similar to that of the vertical direction moving mechanism unit **6**, for example. That is, the horizontal direction moving mechanism unit **8** is configured to have a guide rail **81** that guides the light irradiation unit **4** in the Y direction, a slider **82** that supports the light irradiation unit **4** along with the vertical direction moving mechanism unit **6** and slides on the guide rail **81**, and a movement adjustment unit **83** that adjusts the sliding of the slider **82**.

Fifth Embodiment

Although an electronic component handler and an electronic component tester according to a fifth embodiment of the invention will be described below with reference to FIGS. **19** to **22**, differences from the aforementioned embodiments will be mainly described, and description of similar matters will be omitted.

The embodiment is similar to the aforementioned first embodiment other than that the configuration of the laser light sources is different.

As illustrated in FIG. **19**, each laser light source **41** according to the embodiment has a light emitting element **411** that emits the laser light L**41**, a collimate lens **412** that is located on the emitting side of the laser light L**41** relative to the light emitting element **411**, a support member **413** that

movably supports the collimate lens **412** in an optical axis direction of the laser light L**41**, a rod lens **414** that is located on the emitting side of the laser light L**41** relative to the collimate lens **412**, and a casing **415** that collectively accommodates the light emitting element **411**, the collimate lens **412**, the support member **413**, and the rod lens **414**.

Each laser light source **41** with such a configuration can narrow down the beam waist by moving the support member **413** along with the collimate lens **412**. In this manner, it is possible to reduce the width of the laser light L**41** than the device size (the size of the device) and thereby to irradiate the device with the laser light L**41** with a linear projection shape. In this manner, it is possible to direct the laser light L**41** to a part of the IC device **90** and thereby to accurately detect remaining of the IC devices **90** in a case in which the IC devices **90** remain in the recessed portions **161**.

According to the embodiment, it is also possible to change power of the respective laser light sources **41** for emitting the laser light L**41**. In this manner, it is possible to adjust luminance of the laser light L**41** emitted from the respective laser light sources **41** on the test unit **16** to be the same. In this manner, it is possible to adjust the luminance to be the same at the respective measurement points, thereby to adjust a camera gain, and to satisfactorily perform imaging. Here, "changing the power for emitting the laser light L**41**" means causing an output value of the laser light L**41** to exceed a range between a maximum value and a minimum value of rated output values of the laser light L**41**.

With the laser light sources **41** with such a configuration, it is possible to adjust the length of the projection shapes of the laser light L**41** emitted from the respective laser light sources **41** in the Y direction to be the same as illustrated in FIGS. **20**, **21**, and **22**. In this manner, it is possible to adjust luminance of the laser light L**41** emitted from the respective laser light sources **41** on the test unit **16** to be the same.

Also, diameters of the rod lenses **414** (the lengths in the YZ plane direction) in the respective laser light sources **41** differ from each other. In this manner, it is possible to adjust the widths of the laser light L**41** (slit light) emitted from the respective laser light sources **41**. In a case in which each IC device **90** has a square shape in a plan view, and the length of one side thereof is 2 mm, for example, it is possible to adjust the width of the laser light L**41** within 1 mm. In this manner, it is possible to direct the laser light L**41** to a part of the IC device **90**, and therefore, it is possible to accurately detect remaining of the IC devices **90** in a case in which the IC devices **90** remain in the recessed portions **161**.

Although the embodiments of the electronic component handler and the electronic component tester according to the invention illustrated in the drawings have been described above, the invention is not limited thereto, and respective parts that form the electronic component handler and the electronic component tester can be replaced with parts with arbitrary configurations that can exhibit similar functions. Also, arbitrary configurations may be added thereto.

The electronic component handler and the electronic component tester according to the invention may be combinations of arbitrary two or more of configurations (features) of the aforementioned respective embodiments.

The entire disclosure of Japanese Patent Application No. 2018-010855, filed Jan. 25, 2018 is expressly incorporated by reference herein.

What is claimed is:

1. An electronic component handler that transports an electronic component to an electronic component placement unit on which the electronic component is placed, the handler comprising:

a transport unit that transports the electronic component;

a light irradiation unit that irradiates the electronic component placement unit with light; and

a vertical direction moving mechanism unit having a guide that supports the light irradiation unit and guides the light irradiation unit in a vertical direction,

wherein the vertical direction moving mechanism unit has a movement adjustment unit that adjusts a position of the light irradiation unit.

2. The electronic component handler according to claim **1**, wherein the vertical direction moving mechanism unit has a decelerator that decelerates moving speed of the light irradiation unit.

3. The electronic component handler according to claim **1**, wherein the light irradiation unit has a first laser light source that emits laser light along a first optical axis and a second laser light source that emits laser light along a second optical axis, and

wherein the handler further comprises

a first turning mechanism unit that turns the first laser light source, and

a second turning mechanism unit that turns the second laser light source.

4. An electronic component handler that transports an electronic component to an electronic component placement unit on which the electronic component is placed, the handler comprising:

a transport unit that transports the electronic component;

a light irradiation unit that irradiates the electronic component placement unit with light; and

a vertical direction moving mechanism unit having a guide that supports the light irradiation unit and guides the light irradiation unit in a vertical direction,

wherein the light irradiation unit has a first laser light source that emits laser light along a first optical axis and a second laser light source that emits laser light along a second optical axis.

5. The electronic component handler according to claim **4**, wherein the light irradiation unit has a support unit that supports the first laser light source and the second laser light source.

6. The electronic component handler according to claim **4**, wherein the vertical direction moving mechanism unit has a first support unit that supports the first laser light source and a second support unit that supports the second laser light source.

7. The electronic component handler according to claim **4**, wherein the first laser light source and the second laser light source are disposed in the vertical direction, and

wherein when a straight line extending in the vertical direction is assumed to be a vertical line, an angle between the second optical axis of the second laser light source and the vertical line is smaller than an angle between the first optical axis of the first laser light source and the vertical line.

8. An electronic component handler that transports an electronic component to an electronic component placement unit on which the electronic component is placed, the handler comprising:

a transport unit that transports the electronic component;

a light irradiation unit that irradiates the electronic component placement unit with light;

a vertical direction moving mechanism unit having a guide that supports the light irradiation unit and guides the light irradiation unit in a vertical direction; and

a turning mechanism unit that turns the light irradiation unit.

9. The electronic component handler according to claim **8**, wherein the turning mechanism unit has a decelerator that decelerates an angular speed of the light irradiation unit.

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